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American Foundrymen's Association

CORES AND CORE MAKING

BY F. R. CHENEY, BELOIT, WISCONSIN.

In discussing the core question, whether in regard to the sand, the mixing, or the binders used, shop conditions and output demanded are naturally very important factors. The remarks to follow are therefore not intended as specific instructions for making any particular cores.

As all pig irons may be called good irons when properly mixed, and used in the right place, so all core binders are good for their respective lines of work, when treated with the proper degree of intelligence.

Core binders may be divided into two general classes. First, those oils or binders not easily affected by moisture, such as linseed oil and its adulterations, dry black compounds, rosin, etc. Second, Starches or binders readily affected by moisture, such as flour, glue, molasses, and combinations of similar materials.

The deepest research so far made into the annals and history of the core room, fails to show a single instance where the core binder salesman and demonstrator did not make a good core, at a very attractive ratio of binder to sand, no matter what binder or compound he had, nor what kind of sand he used, whether it was bank, pit, lake, river or mountain, he made you a smooth, firm, strong core at anywhere from one part of binder to fifteen to ninety parts of sand—and why? Simply because he was a good mixer. If he was up against a well managed core room and had to show a high mixing ratio, perhaps those watching him wondered if he would not wear the sand out by rubbing it before making it into a core. But no—

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he knew that he only had one part of compound that must come in direct contact with eighty parts of sand to make a satisfactory core, and the way to get it there was to rub and mix it most thoroughly. Not just to shake it through the riddle and let the outer edge of a conical shaped pile have ten parts of binder to one of sand, caused by the globules of binder rolling down the outside, leaving in the middle of the pile about one of the binder to one hundred fifty parts of sand. He mixed his materials together thoroughly by rubbing, thus making a good core when properly baked.

In foundries that are taking off a heat every day it is not quite as necessary to be so particular as to whether the binder is liable to be affected by dampness or not, for the reason that the core does not often remain in contact with the green sand long enough to become soft from the absorption of moisture in the molds, but where the time of the heats is uncertain and green sand work done, it is much safer to use a binder that is as little affected by dampness as possible.

A core made with a binder that is sensitive to moisture may come from the oven in perfect condition and yet if it remains in a green sand mold for 24 hours be the cause of blow holes in the casting on account of the dampness absorbed. It is possible for cores made with flour, glue, molasses, or similar material, when left on shelves in a partially open room, during wet weather, to look all right and yet to have absorbed enough moisture from the air, to ruin every casting in which they might be used.

Cores made from Linseed oil or a high grade of core oil, having linseed oil as the base, or the dry black compounds having coal-tars as the base, can be handled without very much regard to weather conditions. They may be kept for weeks in an open shed, where the rain and snow can pass over them, without injury to the cores and without danger of a "blowed" casting

when using them, if they are dried before placing in the mold.

The proportion of binder to sand depends on the thoroughness with which the two are mixed together, as well as on the quality of binder, grade of sand or size of core.

If the quantity of cores used will warrant the installation of a mechanical mixer, material as well as time can be saved. As mentioned above the successful demonstrator rubs the binder and sand together. This can be done mechanically with the old fashioned sand- or mud-mill, and about 25% of binder saved over the hand way of a riddle and shovel mixing process. This for the reason that the heavy iron roll traveling in the pan kneads and mixes the mass thoroughly in a very few minutes, one or two "V" shaped plows hung in the pan assisting in keeping the stock stirred up while the roll is pressing it together.

The mud-mill will also grind up the old cores. In using over the completely burned cores, it is difficult to properly temper the burned sand on account of its apparent so imperviousness to water if the operation is undertaken by hand, but with the mud-mill, throw in the burned sand, gang way sweepings, or other fine refuse, and dry black compound in the ratio of one part of compound to twenty to eighty parts of old sand, depending on how completely the old cores were burned out, without any new sand or clay wash at all, and in less than five minutes you can have as good a batch of core stock as is needed for most cores. Cores 5 ft. long by 3 ft. wide by from 1 inch to 6 inches thick are being made successfully every day with nothing but old sand and the dry black compound in the ratio of one part binder to thirty parts old core sand and gang way mash. To accomplish this result, the dry sand is first put in the mill then one part of binder to thirty parts of the sand, the mill allowed to revolve a few times to mix the sand and binder while dry, then the water is turned in until the mixture is wetter than is used for any other kind of binder, in fact the stock is almost mushy.

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In making cores, see that the core box is clean to insure a smooth draw. For general work, throw the sand into the box by hand with sufficient power to force it into all the corners and angles. Then continue putting in sand until enough is there to support the core rods without danger of the rods cutting through the sand when they are firmly pressed down. The more crooked and the rougher the rods, the better they will tie and hold the stock together. After the rods are placed fill and heap up the box with sand, then ram with a large flat rammer and hard enough to compress the entire stock into one firm mass, but do not make such a hard core that the iron will not remain quietly on it.

As a precaution against cores coming apart, avoid as far as possible building them up in layers either by ramming evenly every 2 or 3 inches, or placing layers of straight core rods simply crossed, or putting in vent material in the shape of coke, sawdust, etc., in layers that are too even.

A core can be properly baked with either a slow or a hot fire, but can not turn out well when the flame comes in contact with the surface of the core, for in that case the binder is disintegrated.

Do not neglect your core room or think the making of cores a secondary consideration. Quite often the most intricate part of the mold depends on a core, which, also quite often is given to some boy to make, (because it means merely putting sand in a box and then baking it), instead of to a coremaker of experience. If a foundry is short of experienced molders, the judicious use of cores as slabs and to tie to the cope for deep lifts will permit an apprentice to do work that otherwise might have to wait some time.

Bear in mind that no matter how well your iron is bought and mixed by expert metallurgists; no matter how hot it comes from the cupola by the best of melting practice; and no matter how perfect and clean a mold you have made, by men of years of experience; if you put into that mold a poor core, your casting will be scrap and your expert labor instead of yielding revenue, but dead expense.

AMERICAN SOCIETY,
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American Foundrymen's Association

REPORT OF COMMITTEE ON INDUSTRIAL EDUCATION.

INTRODUCTORY

Your Committee on Industrial Education has the pleasure of reporting progress in its efforts to bring the educational interests of the American Foundry Industry nearer to the goal where that kind of general and specific vocational education will find national recognition. This alone can form a firm basis, from the standpoint of both labor and capital, for the further material welfare of our industries in general and that represented by the American Foundrymen's Association in particular.

It is becoming more and more recognized that the solution of the problem or vocation education of the industrial as well as agricultural workers of both sexes of all kinds and grades, must be sought in conjuction with and through the instrumentality of our school organization. Even the best of our shop schools can meet a purely local and individual limited demand only. Lack of preparatory training and a dormant mind induced by two or three years of mental inactivity before entering a chosen vocation, incapacitates all but the brightest for continuous mental activity, and forces the shop school to do work that ought to have been done in the public school. Hence we can not but stop short of the progress desired. All present trade schools, technical schools, manual training high schools and manual training departments of high schools are hindered in their work for the same reasons, namely, lack of suitable early training in a similar, manner as the school provides preparation for the professions in systematically arranged successive steps.

PRESENT ASPECT.

With the declaration by the National Education Association of the United States in favor of industrial education, at its last annual convention in Cleveland, we have arrived in the history of the industrial education movement in the United States at the point where the public school declares its proper responsibility for the training of the masses of our youth for vocational life. The recognition of this responsibility, by the largest and oldest national association of educators, gives the industrial education

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movement a distinct national character and stamps it an issue of national importance.

The National Society for the Promotion of Industrial Education, with its State branches, likewise emphasizes the national character of industrial education. The efforts of this Society are directed toward arousing and educating public opinion to realize the need of providing liberally for the industrial education of the workers.

The National Association of Manufacturers, through its Committee on Industrial Education, is eneregtically engaged in spreading the gospel of industrial education all over the country. The National Association of Builders' Exchanges is likewise in the forefront for the training of our youth along vocational lines, and their wide-awake Committee on Industrial Education leaves no stone unturned to promote the educational interests of our industries in general and of the National Association of Builders' Exchanges in particular. In its annual report just issued, the Committee on Industrial Education of that association, emphasizes the fact that the idea of industrial education is becoming universally recognized, and therefore the means of attaining this education must be of national extent. Your Committee takes pleasure in quoting a paragraph from the above-mentioned annual report as showing the recognition of the endeavors of your Committee to co-operate freely with all social agencies in the interest of the American Foundrymen's Association. "Through the efforts of your Committee, we have also been very fortunate in arranging through correspondence and personal consultation for the advice and assistance of Mr. Paul Kreuzpointner, Chairman of the Committee on Industrial Education of the American Foundrymen's Association, and Mr. Kreuzpointner's aid in this direction has been of untold benefit to your Committee, and in this connection desire to state that the Association which Mr. Kreuzpointner represents has also been actively engaged in the subject of Industrial Education for a number of years past." The report also quotes paragraphs from an address by the Chairman of your Committee.

Last but not least among the forces now at work to secure for Industrial Education its proper sphere of usefulness in the educational system of our country appears to be a disposition among union labor to recognize its social value. We can report with sincere gratification that a representative organ of organized Labor, "The Labor World," published at New York, opened its pages willingly and cheerfully for the publication of a two column article on industrial education contributed by the Chairman of your Committee. Credit should be given to the editor of "The Labor World," Mr. Leon C. Sutton, for this exhibition of a co-operative spirit, which, if cultivated on both sides with a spirit

of kindliness and mutual forbearance, can not but react favorably to the benefit of every one concerned.

INDUSTRIAL EDUCATION A SOCIAL FORCE.

This awakening of social forces in the interest of industrial education is in accordance with the social necessity of the age for a system of industrial schools upon broad educational lines. Industrial education should not only mean the acquisition of skill of hand and the mastery of mechanical processes, but also the acquisition of scientific principles underlying mechanical operations. This fundamental aim of industrial education should, however, be supplemented by the training of the workers in understanding the relation of his work to the welfare of the community he lives in, as well as to the Nation at large.

In the industrial school to come, the prospective industrial worker, as well as the prospective engineer, should be made to see that mere manual dexterity, scientific knowledge, and the mathematical perfection of mechanical processes, are one-sided possessions in the struggle with keen competition, if not smoothed by an additional training in civic duty which tells the industrial worker, be his station in life ever so humble, that as a man and a citizen he is morally bound to see to it that his fellowmen and those who come after him are not curtailed in their enjoyment of life as he himself expects to enjoy life. If the mechanic, be he ever so skillful, or the laborer, be he ever so strong and quick, carlessly or ignorantly waste time and material or slights his work, then he increases thereby the cost of production in various ways unnecessarily, and lessens the chance of its sale through higher cost in competition with other more prudent concerns or industrial nations. Hence he does himself and others more or less harm by lowering wages or loss of work, or both. On the other hand the diminishing of our resources of raw materials by careless waste makes living harder and more difficult for those who come after us. In either case it is an immoral act of the mechanic as a man to injure others in one way or another, if he can avoid doing so by learning how.

Whatever differences there may be between capital and labor, the latter will not improve by neglecting the opportunity to become skillful to earn more, but by using that skill for a more economic, a more scientific use of our mental and material resources, for more economic municipal housekeeping and the exercise of a greater co-operative spirit. For the same reasons, and self-preservation in addition, this duty likewise devolves upon capital. Lavish waste of time and material enriches a few. Judicious economy without penuriousness secures greater permanency of raw materials and continued prosperity to the many.

And if this broader industrial education, all too meagerly outlined above, has any right to be heard of in the councils of our

industries, it is for reason of waste of talent, intelligence, and mental and moral discipline, in the years after leaving school now going on.

No nation, however wealthy in material resources, can afford to lavishly waste the talents and intelligence of its children as we do in industrial America. Our school organization, with a feeble, inadequate attempt at a remedy here and there, is still the school of two generations ago when it had no part in solving the general problems of life; where the teacher was not expected to know and do more than to teach from the book, and when the home and public life was the real educator of the child; and when the school did not yet, as it does now, pour its thousands out of crowded school rooms into the unhygienic and monotonous environments of factory life. The child forgot what little he or she had learned and had mind and body stunted and made unfit for the coming years of the duties of vocational life and citizenship.

The State asserts the right to keep the children in school for a given period in order to secure that intelligent citizenship which is necssary for the preservation of our institutions, peace and order. But with the exception of a tentative beginning in two or three regions, the State makes no provision to follow up its own advantage in the possession of this power, to broaden that intelligence in conformity with the needs of the complex requirements of modern life. It is satisfied with prescribing a homeopathic dose of learning in its schools to be speedily neglected, and wasted in the general scramble of the children to get into factory and store to earn some spending money, after hold of the State upon the child is released at fourteen or sooner. Thus we allow individual and private interests to practically destroy the investment the State had made by permitting child labor, and laboriously, but always insufficiently, try to regain the lost ground in evening schools in later years, when the mind has been made unreceptive by earlier mental inactivity.

This procedure of wasting mental resources we call enterprise and business shrewdness. As an observant economist rightly says: "The productivity of capital depends on several factors: 1. On scientific mastery of the laws of natural forces and materials; 2. On the invention and use of the most perfect tools, machines and technical processes; 3. On the perfection of the organization and discipline of the factory, mill or shop; 4. On the selection of raw materials and arrangement of the plan of manufacture; 5. On the health, energy, intelligence and hearty co-operation of the workmen. It is this last factor which with us is too much neglected, and the most important of all."

Formerly the home was made responsible for the final results of training and education of the children. Now, this responsibility

is more and more thrown upon the school and the school is not provided with the instrumentalities for assuming this responsibility to the fullest extent. Between the imperfection of the two the child suffers, industries suffer, and the State suffers in the long run. The inventions of the age have deprived the home of most of the work wherein boys and girls found exercise for their energies and talents, as well as discipline. Necessity on the one hand, and the craving for society on the other, keeps the father away from home most of the time, depriving it of much of his beneficial presence. The mother gets worn out with the multitudinous household cares, for which perhaps she was poorly prepared in the first place, and the children acquire as their chief incentive in life a desire to earn money for amusement and display, if they are not confined to the street altogether for their play and recreation.

The school claims them a few hours, but does not interest them sufficiently to keep them longer than they must stay. Thus latent talent, productive capabilities, mental, moral and physical possibilities for good, for their own usefulness and that of society, are left lying dormant, and what little there was aroused in the school is not cultivated further but lost again to the child and to society, by not providing a continuous system of education for the millions of industrial workers as we provide it for the hundreds in the professions.

We honor the professional man who has spent many years in preparing himself, but we discourage the industrial worker from spending time and money to prepare himself as efficiently proportionally for the larger duties of his life. Anyone who has had the opportunity to deal with the mental qualifications of large numbers of young men after they have been out of school two or three years and were at work during that time, can not but be impressed with the lack of perceptiveness, receptiveness and general dormancy of their mental faculties in the case of all but the brightest ones, proving the grevious waste of what should be one of our most valuable national assets, the mental resources of millions. It is serious to think that the destiny of our Nation lies in the hands of millions whose immature minds have thus been dwarfed by premature mentally sterile factory or other occupations.

While it is true that the child going to work acquires certain habits of industry, of self-reliance, of dexterity of hand, of quickness of perception, the value of these acquisitions is doubtful because their effect is one-sided, arresting further development, producing weariness for mental effort. They destroy the balance between mental and physical effort and create an unnatural desire to counteract the weariness of mind by excitable amusements and demoralizing recreation. Besides the money

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earning power of the immature boy and girl creates false notions of social independence of conduct, and consequent liability to disregard personal and vocational obligations later on.

The child labor movement has no sounder, no more effective, no more justifiable anchorage in its claim for social welfare than the contention that premature work of the child, under the mentally deadening conditions such child work is usually carried on, is demoralizing and degenerating to the mind, body and morals of the child, unfitting it for the complex duties of citizenship later on.

Your Committee has considered it a duty to call attention to this social side of the problem of industrial education because this education envolves the question of bread and butter, shelter and clothing, of public peace and order, and the attributes of civilized life for the manufacturer, the business man and railroad officer as much as it does for the mechanic and laborer. Industrial education, to be of nationally constructive and lasting productive value, must go farther than merely trying to serve one particular industry, it must go farther than trying to serve the mechanical needs only of all industries; it must try to serve the social needs of society by raising the man and citizen to as high an intellectual standard as we try to raise the mechanic to a higher level of skill. Then the harmonious development of both will produce that degree of industrial intelligence which must give us the fifth essential to successful productivity of capital and labor: viz., health, energy, intelligence, co-operative spirit and earning capacity.

To attain this end we can have nothing less than a system of industrial continuation schools, branching off from the seventh or eighth grade, serving general industrial purposes up to sixteen years of age, and then becoming specified trade schools as instructors to those engaged in trades, similar to what the new New York law contemplates. These schools to be supported by both the State and the community, making attendance compulsory up to fifteen years of age, and the employer recognizing the increased intelligence by a better wage which will induce parents to send their children to school instead of to the factory.

The New York law favors the establishment of industrial schools for pupils from 14 to 16 years of age and trade schools after the age of 16 years has been attained. The State appropriates five hundred dollars annually for the maintenance of a teacher of such an industrial or trade school and two hundred dollars for every additional teacher. Manual training schools are left undisturbed and receive no State aid.

CO-OPERATION BETWEEN SCHOOL AND INDUSTRIES.

The school has declared itself the custodian of industrial education, and the public school being a public institution, supported

by the earnings of industry and agriculture, and declaring its willingness and obligation to train our youth in such a way that they are able to produce their necessary share of taxes to maintain the school and all other public institutions in a high degree of efficiency; the industries are naturally interested to know how far the school is equipped to meet this enlargement of its obligations. In conventions and otherwise the professional educators admit the failure of our educational system to meet the present educational crisis. They are sincerely and energetically trying to find remedies how to adjust the school to the new requirements. But they are handicapped with lack of familiarity with the complex influences prevailing in our industries. They are hindered by traditions and outside influences of great power. The retarding effects of such unavoidable hindrances could be largely overcome by both the educational and industrial forces joining hands in a co-operative spirit by making concessions and comparing notes. Your Committee will enter more deeply into this question at some future time.

In this connection your Committee begs to express its sincere appreciation of the hearty co-operation of many of our noted educators. The chairman of your Committee has faithfully endeavored to reciprocate these courtesies in every way possible. For instance, while sojourning in one of the larger cities of the Northwest some months ago, your chairman learned of the unwarranted opposition encountered by the superintendent of schools of that city in his efforts to raise the schools to a higher degree of efficiency. The superintendent was clearly right and the measures he advocated were for the best interests of the teachers, the schools and the community. Your chairman called upon the superintendent, assuring him of his sympathy and co-operation, and then called upon a number of prominent citizens for the purpose of urging them to assist and stand by their superintendent in his difficulties.

Your Committee has been asked, in various ways and forms, what lasting good is to be derived by capital and labor and society at large from this emphasizing of the value of industrial education. From this storing up of a reserve fund, as it were, of a higher degree of mechanical skill, scientific knowledge, industrial intelligence and greater reasoning power, by the masses of industrial workers who may never be called upon to make use of that reserve fund of intellectual power and knowledge, and therefore effort is wasted on the one hand and discontent created on the other by the surplus possession of qualities which he or she was told would inure to their increase of material benefit.

Your Committee recognizes the apparent justice as well as the gravity of the question and will endeavor to answer it at some

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future time in a specially prepared monograph, in order not to unduly lengthen this report. This much your Committee begs to say at present: Can any industrial nation of today, whether the form of government is monarchial or democratic, maintain its industrial standing and standard of civilization with the mental resources of tens of millions of its citizens lying dormant and undeveloped, and kept so for want of instrumentalities to develop them? And mental inactivity means mental stagnation, and mental stagnation means mental and moral retrogression, and mental and moral retrogression means mental and moral turpitude; it means vulgarity and rudeness where there ought to be gentlemanly conduct; it means bayonets to rule where reason should; it means passive, if not active and violent, opposition to that mental, moral and physical discipline which must keep all industrial, religious, social and commercial organizations together and beneficially active. No amount of expensive supervision, in public life or in the shop, however highly organized and specialized, can be a substitute for self directing reason, and that industrial nation which tries to substitute mental dormancy and artificial supervision for intelligent reasoning of its industrial workers, is doomed.

It may please the members of the American Foundrymen's Association to know that a request was received from the German Foundry Journal, of Berlin, to furnish photos, etc., of the lecture on the Guilds of the Middle Ages, delivered by the chairman of your Committee at the Toronto Convention, for republication in Germany. Thus bringing the American Foundrymen's Association creditably before the attention of our German friends.

The letter by your Chairman in answer to an inquiry by Prof. F. B. Cooper, Supt. of Schools, of Seattle, Washington, has also created universal interest and attention, and Prof. F. B. Cooper not only deserves credit and the thanks of the American Foundrymen's Association, but the thanks of every intelligent and patriotic citizen, for raising a question of such profound import to the welfare of our country in such an admirable way. In conclusion your Committee would urge the members of the American Foundrymen's Association to join the American Society for the Promotion of Industrial Education as this organization, by its concerted action through members of many different occupations, and from all parts of the country is well fitted to spread the gospel of industrial education.

Your Committee finally begs leave to express its sincere thanks for the co-operation and confidence received from the members and officers of the Association.

PAUL KREUZPOINTNER,
Chairman.

American Foundrymen's Association

CONTINUOUS MELTING IN FOUNDRY OF WESTINGHOUSE AIR BRAKE COMPANY

S. D. SLEETH, WILMERDING, PA.

When the Westinghouse Air Brake Company found it necessary to enlarge their plant, on account of increased business, it was decided to move to Wilmerding, Penna., and install in the foundry flask and sand conveyors. This meant that the foundry would have to run so that iron could be poured all day, instead of two or three hours in the afternoon. We knew of no plant where this was being done, so it was up to our foundry to work it out. As it required about two and one-half hours to run the heat off at that time, we decided to see how much longer we could hold the metal in the cupola and still keep it hot. The first day we put the blast on one-half hour earlier and melted the iron with the same blast pressure, but would shut the blast off for five or ten minutes and then start to blow again. This we found to work satisfactorily for that day. The second day we put the blast on one hour earlier, but this did not work so well, we therefore added more coke, which kept the metal hot but the melting was slower.

When we started work in the new foundry at Wilmerding we ran two cupolas, one in the morning and one in the afternoon. We were afraid to hold over dinner hour. After running for some time in this way we decided to run one cupola all day; at 11 o'clock, or a little later, we added 200 lbs. of coke for two or three charges so that we would have an extra amount of coke

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to hold over the dinner hour. Our great trouble at this time was with the cupola man, as he insisted that the iron would freeze at the tapping hole, but we finally persuaded him that he would not be held responsible should this occur. We drained all the iron out at 12 o'clock and closing the slag hole with sand, stopping the tapping hole, and shutting all other openings tight, so there would be no draught. About ten minutes before starting time we tapped out all that was in the cupola and pigged it, then put the blast on full, so as to be ready when the starting whistle blew. Sometimes we have to pig two or three hundred pounds on account of the metal not being hot enough.

We had two sizes of cupola —48" and 60" inside the lining. When the heats were heavy we would run the 60". We had to enlarge the plant again so we took out the 48" cupola and installed two new cupolas, the shells being 90", so that we could line them up to 78" if required. We have them lined at the present time to 70". When running full, i. e., night and day, we melt 280 tons, running each cupola about ten hours. We have operated one cupola from Friday night at 6 o'clock until Saturday noon of the following day, closing down at 11 P. M. for one-half hour for lunch, and again at 6.30 in the morning for three-quarters of an hour for breakfast. This is rather hard on the lining so we do not make a practice of it.

We have tried a great many experiments with cupolas, but as yet have been unable to find any that will give better results than the double row of tuyeres—the upper row about 10" above the lower. It is not necessary to keep the upper ones open all the time. Our blast pressure is about 11 ounces in the cupola bustle. We use a fan for blast. When running full we melt ten to eleven pounds of iron to one pound of coke.

In charging the cupola we are very careful to have the charge level. We charge the pig by hand and the scrap is dumped in from a buggy through a door above the regular charging door. All the charges are the same from beginning to the end of the heat. As the iron must come very soft and uniform we do not charge more than 4000 lbs. at one time. For a smaller cupola the charge would naturally be less.

To sum up our experiences, I would advise: See that the

coke bed is burning even all around, then charge just as you would for an ordinary run, allowing an extra amount of coke for the dinner hour. After running about one hour, open the slag hole and keep it open, except during the dinner hour. Use about 40 to 50 pounds of limestone to one ton of molten metal —better to use too much than too little. Have the cupola shell large enough, as it is easy to put in an extra lining for smaller heats.

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American Foundrymen's Association

THE PRACTICAL VALUE OF CHEMICAL STANDARDS FOR IRON CASTINGS

BY JOHN JERMAIN PORTER, UNIVERSITY OF CINCINNATI.

In the final analysis, the test of a successful foundry is its ability to make money for its owners, and the three factors which determine its success are: 1st, ability to make good castings; 2d, the ability to make good castings cheaply; 3d, ability to sell its product at fair prices. Since the composition of the metal going into the castings has a large influence on both the first and the 2d of these factors, we may perhaps be pardoned for again unearthing this ancient subject and may be permitted to consider it in its direct relationship to the commercial success of the foundry.

There are four factors on which the quality of a casting depends: the chemical composition; the treatment which the metal has received in melting; the heat treatment, i. e., casting temperature and rate of cooling; and the perfection of the mold. These four factors are probably of nearly equal importance and each of them is deserving of far more systematic and extended study than has yet been given it.

The cost of castings is not so greatly influenced by their composition and is perhaps chiefly a problem in the making of molds. In certain cases, however, it may play an important part, since the number of wasters or spoiled castings is often closely associated with the composition of the metal and, as all foundrymen know, there is nothing which will send the cost up so rapidly as a large percentage of bad castings.

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The cost is also influenced by the chemical composition of the metal in another way. That is, by the cost of the iron used. This comes about from the fact that for any given casting there will be several different compositions, or perhaps a wide range in composition, any one of which is equally good. Some one of these, however, will be cheaper than the rest and hence the foundryman who works according to analysis and with full knowledge of his requirements in the way of composition can effect a saving in cost which, though small, is not unimportant.

As an example of this, I would mention the case of the ordinary run of machine tool castings which are so commonly made in the foundries of this district. These castings are of medium thickness and must be soft enough to machine. Owing to the fact that the foundry is not commonly considered to have any rights that the machine shop is bound to respect, our foundry superintendents have had it most firmly impressed upon them that no crime is so heinous as that of turning out hard castings, and hence the custom has grown up of using from .25 to .50% more silicon in these castings than is necessary in order to insure immunity from machine shop kicks. In other words, 2.25% to 2.50% silicon is very frequently used in work where 2% is quite sufficient. Now, if we examine the market reports of the price of pig iron, we find that there is an average difference of 50 cents per grade number per ton of pig iron; i. e., if No. 2 sells for $14.75, No. 1 will sell for $15.25. It is also a fact that the grade numbers represent a variation of 50% of silicon, i. e., No. 2 averages 2.25% and No. 1, 2.75%. Thus it may be said that each .01% silicon costs 1c. and if we use .25% more silicon than is necessary in our mix, we unnecessarily increase the cost of our metal just 25c. per ton.

This may seem like a small thing, adding, as it does, only one-eightieth of a cent per pound to the cost of the castings, yet, when we consider that the excessive amount of silicon used has a very injurious effect in the way of producing dirty iron and porous places in the heavy sections, and thus is sometimes accountable for a considerable number of spoiled castings, the point does not seem so trivial.

Another case is found in the extensive use of manganese by some of our best informed managers who have learned to ap-

preciate its excellent effects in giving clean, sound iron, and in reducing the scrap pile. One of my foundry friends tells me that by the use of high manganese pig iron he is enabled to use large amounts of very cheap high sulphur pig, the manganese counteracting the injurious effects of the sulphur and being itself comparatively inexpensive.

This same friend also says that he has not had a ton of No. 2 iron on his yard for months, his requirements being obtained by mixing a cheap high silicon high sulphur iron with other cheap low silicon high manganese irons. Of course with this procedure, very close attention to the details of charging and the methods of receiving the iron in ladles is necessary, but the fact that it can be and is done successfully is worthy of careful attention by our members.

An erroneous idea, resulting from lack of confidence in the competency of mixing purely on the basis of chemical composition, is held by some foundrymen in the middle West. These men will tell you that it is very difficult to make satisfactory castings from northern iron or southern iron alone but that a mixture of northern and southern brands is necessary for satisfactory results. No doubt this idea had its origin in the days when the grading of pig iron was done entirely by fracture. Southern pig iron averages high in silicon, sulphur and phosphorus. Northern iron averages low in these same elements. Hence by a mixture of these two, a happy medium was usually obtained. However, there are some brands of southern iron which are low in phosphorus and which may be obtained with any desired silicon and sulphur, and by the use of these southern irons of correct composition just as good castings may be made as though a mixture of northern and southern iron giving the same composition were used. The advantage of this knowledge lies in the fact that southern iron can usually be obtained at a somewhat lower price than northern iron for corresponding grade numbers. At the present time the difference, in this market, is only 20c. per ton as between northern and southern No. 2, but this difference is sometimes as high as $1.50 per ton, so that an important economy is open to the man who understands mixing by analysis and is not afraid to use the largest possible proportion of southern pig.

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Many other examples might be cited showing the heavy penalty paid by some operators for their lack of knowledge of this subject, or lack of appreciation of its importance, and it is probable that there are but few plants where some improvement in cost or quality could not be made if all the information available were applied.

This naturally brings us to the reason why our knowledge of foundry metallurgy is not more generally used since foundry operators are certainly not less enterprising or less desirous of economically conducting their business than we technical men who try to tell them how to do it. The answer to this question, may, I think, be found in the fact that the various data have not been gotten together in such form that the practical foundrymen can readily use them. It is well known that within recent years, especially, vast additions have been made to our store of information regarding cast iron, but two facts militate against the use of most of it. The first of these is that but little of this material has been gathered together in handbooks or in such form as to be readily available for use. Most of it, and that the most valuable part, has been published in the various technical journals, and the foundryman who wishes to find the best kind of iron for making hydraulic cylinders, for example, would have to search through the files of perhaps a half dozen journals, and it might take him two or three days to dig out all the information available on the subject. The other factor is that so much of the material published is written up from the scientific point of view rather than the practical, and hence is not in a form to be understood and applied by the foundryman who has neither the time nor inclination to dig out the meaning of the diagrams, microphotographs, and long-winded scientific explanations offered.

It is true that this scientific work is of the highest importance, indirectly, but it needs to be thoroughly digested, correlated with practical experience and the results restated in ordinary foundry language in order to make it available for practical use. There has also been done an enormous amount of technical experimental work which fails to be of value because of incompleteness, for example, data connecting the strength of iron with varying percentages of silicon are meaningless unless the percentages of

other elements are also given. Moreover, statements that an iron of a given composition has such and such a strength is of very little use taken by itself since the value of a casting is seldom dependent upon strength alone and there are many other properties of cast iron, such as hardness, shrinkage, density, etc., which must also be considered.

Looking at it from this standpoint, it will be seen that the problem is very complex and not to be approached lightly. Some twenty different physical properties of cast iron may be enumerated which influence its value and adaptability for the manifold purposes for which castings are used. Cast iron may be regarded as an alloy of six elements, i.. e., iron, carbon, silicon, sulphur, phosphorus and manganese, and since these elements may be combined in various ways, we may have some twelve or fifteen different constituents. Now, since each separate constituent has or may have a specific effect on each of the twenty physical properties, it will be readily seen that if the problem is to be investigated systematically from start to finish an almost infinite amount of work will be required. To illustrate: if each of the six elements is varied in only seven proportions and each resulting metal tested for each of the twenty physical properties, 2,352,980 different experiments will be required. Evidently, then, any such review of the field as outlined here is entirely impossible at the present time.

As a matter of fact, such an accumulation of data would, after all, give us only half the information we require, since in a great many, perhaps the majority of cases, the exact physical properties which are necessary to make the best casting of any particular class are not well defined. For example, to take the case of a foundryman making hydraulic clyinders, even supposing that he had all this data at his command, it could not aid him unless he knew also, exactly what degrees of hardness, strength, density, etc., are most desirable in his cylinder.

Evidently, then, the most feasible way of placing this metallurgical data before the foundryman in such form as to make it of practical value, is to first classify castings according to the physical properties which are of importance in them, and then to tabulate the chemical compositions which are found suitable for each class. It would also be highly desirable to take some

cognizance of the factor of the cost of the mixture and show, where possible, how the foundryman could cut down the cost of his iron without decreasing the quality of his product.

An investigation carried out along these lines, while involving considerable work, would not be impossible and would certainly be of immediate and direct benefit to the foundry industry. The data needed could be obtained very largely from material already published and from inquiry among plants making the various lines of castings. Some experimental work would undoubtedly be needed to fill in the gaps, but I do not believe that it would be very great in amount.

With regard to the classification of castings, Thomas D. West has outlined a system of classification and divided castings into thirty-four classes.* I have not yet looked carefully into this phase of my subject and am therefore unable to say if this classification would be suitable for our purpose or whether a more or less detailed classification or a classification along different lines would be necessary.

In conclusion, it appears to me highly desirable that this subject be taken up by the American Foundrymen's Association and added to the number of those foundry matters which have been threshed out, systematized and standardized under our auspices. I therefore urge that this meeting take under careful consideration the advisability of appointing a committee for the formulation of chemical standards for iron castings.

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*"Suggestions for Procedure in Formulating Standards for General Castings." Trans. Amer. Society Testing Materials, 1903.

the bungs, put in new walls or bottom (when this breaks and comes up), and be ready to charge again when the whistle blows in the morning. No time has been lost, and the furnace is as good as ever.

After an air furnace has been built, I have always found it best to put in a slow fire—without any blast—for a few days. This slow fire dries out the walls and bungs, as well as the stack. Further, the side and buckle-plates have a chance to become heated up, and will not crack so easily afterward. The "bungs" may now be taken off and the "silica" sand bottom put in and baked hard.

I think we are all prone to be in a hurry to charge a new furnace, and I can recall more than one instance where an ambitious foundryman lost his first heat, and hurt several others because he charged before the furnace was properly dried out. Moreover, time was lost in getting the furnace back to its proper condition, besides the loss in production that could not be caught up with again.

The sand used for the "bottom" must bake well. I am a believer in getting the best that can be had, though of course foundrymen must be governed by their location and the adaptability of the local sands. I know of several plants in which Lake Sand is used entirely, and with good results. Old fire brick ground up and run through a No. 4 riddle, when mixed with sharp sand, will make an excellent bottom. Ground fire brick and fire clay mixed up for a daubing for side walls and spout, and to make the breast, give about the best results in that line. The same mixture is used for lining hand and bull-ladles. Old grind stones pulverized fine and rammed down hard, make a furnace bottom that will stand for several weeks.

There is no hard and fast rule for making the plates and stays of an air furnace. Some foundrymen make very large plates—six to eight feet in length and five feet high. I know of one

progressive malleable plant in which the plates are made in sections, and are perforated. They are three to four feet in length, and twelve to eighteen inches wide.

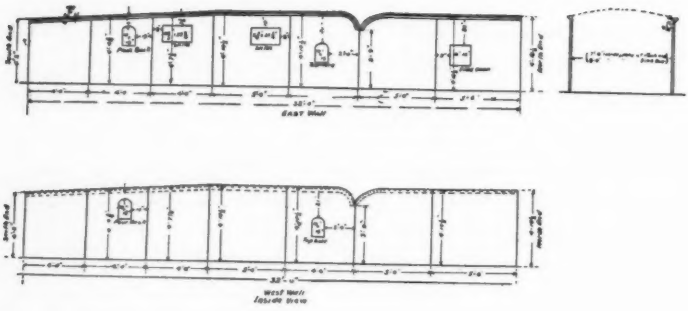
After the plates are set and have been bolted to the buckle-plates, the walls are built to the proper height. Next it is necessary to consider the openings over the bridge walls. This is a most important point, as on it depends the working of the furnace, and the coal consumption. I have the opening over the front bridge wall at eighteen inches centre of bung, back opening six inches centre of bung. A water guage records the blast pressure, which with about three inches and the openings above mentioned gives me good results. A higher blast pressure melts more rapidly, but cuts out walls and bungs faster.

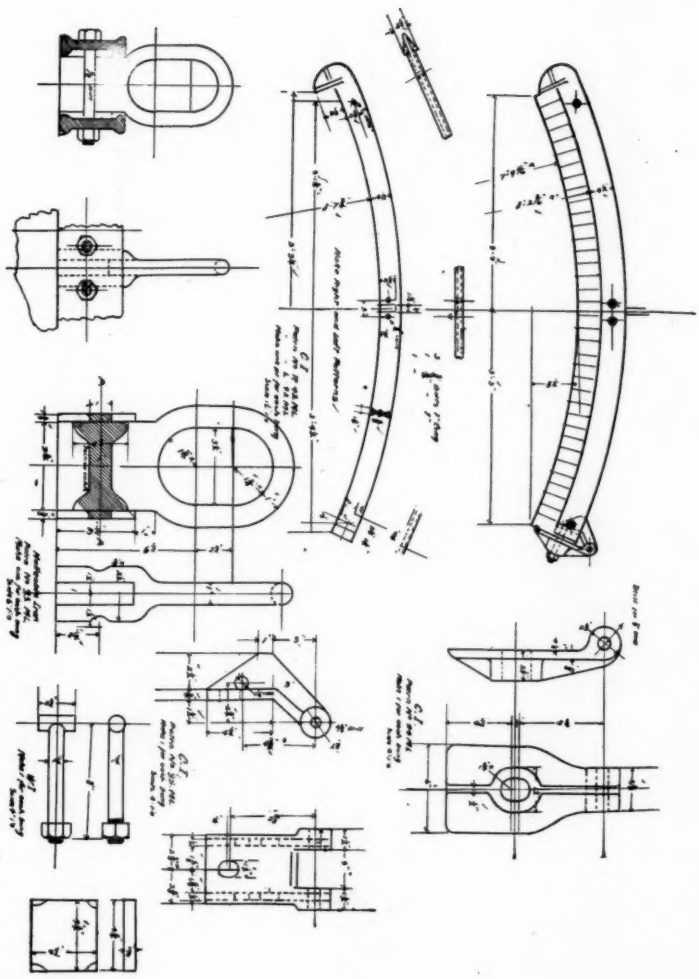
The grate should be at least 12 inches below the door, so that a bed can be carried from twelve to sixteen inches in depth. The bungs for an air furnace are very much a matter of taste with the builder or foundryman. There are various styles in use. One has a single brick or nine inches. Another takes a brick and a half, or thirteen inches, and still another two bricks, or eighteen inches in width. The frame is made in various ways. The old style had rods running the entire length, and could be tightened from both ends. The latest designs work better, and have the tightening accomplished by means of set-screws. These bungs rarely drop out, holding the brick well through the various phases of expansion and contraction.

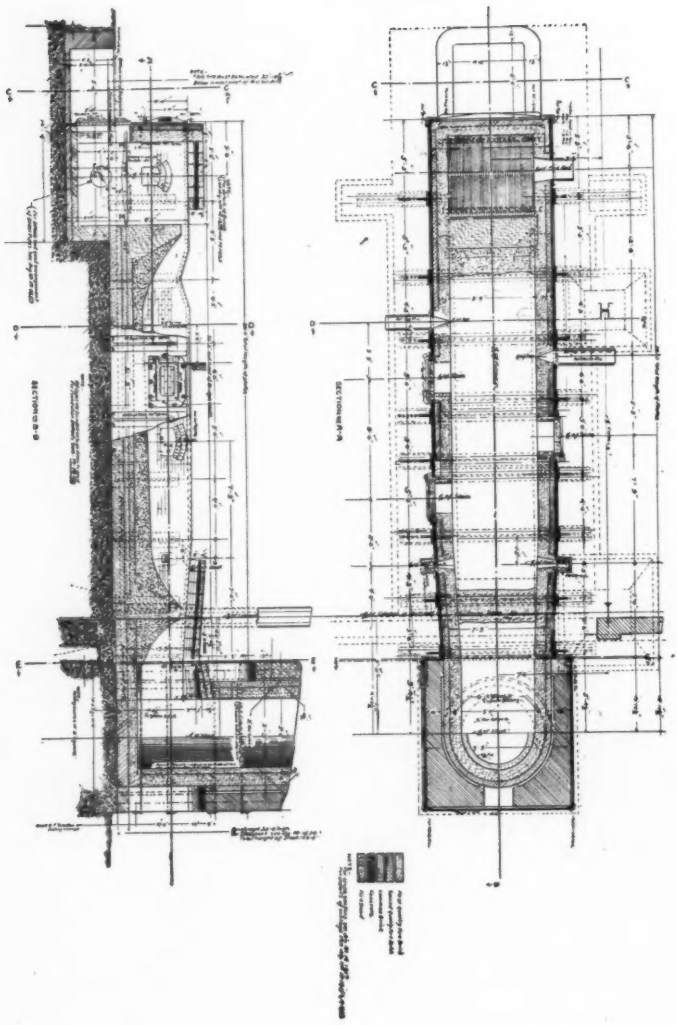
It is further advisable to have a heavy sheet iron hood over the fire door, so that the smoke and fumes that blow out of it may be drawn off. This keeps the air clearer and healthy for the foundry—a benefit that will be appreciated by those most interested.

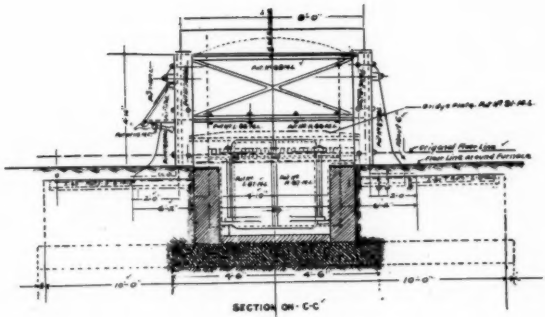
Finally I would recommend the use of a waste-heat boiler in the stack, or back of the stack, with proper damper facilities to use boiler or furnace independently. I have used a two hundred

and fifty HP Cahall Boiler on a twelve ton air furnace with excellent results. Provision is made for a fire box on the boiler so that it can be fired while the furnace is being charged, in fact until after the iron has commenced to melt. After that time, the blow-off valve of the boiler will be working and need looking after.

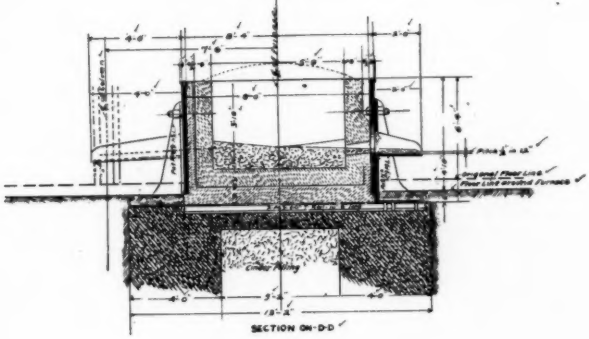








SECTION ON C-C



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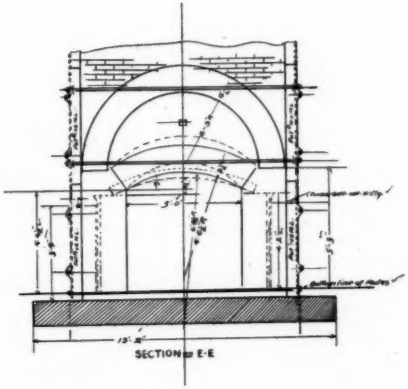

SECTION on E-E

NOTE:-
For details of Steps, see drawings
For location of sections see drawing

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OPEN-HEARTH METHODS FOR STEEL CASTINGS.

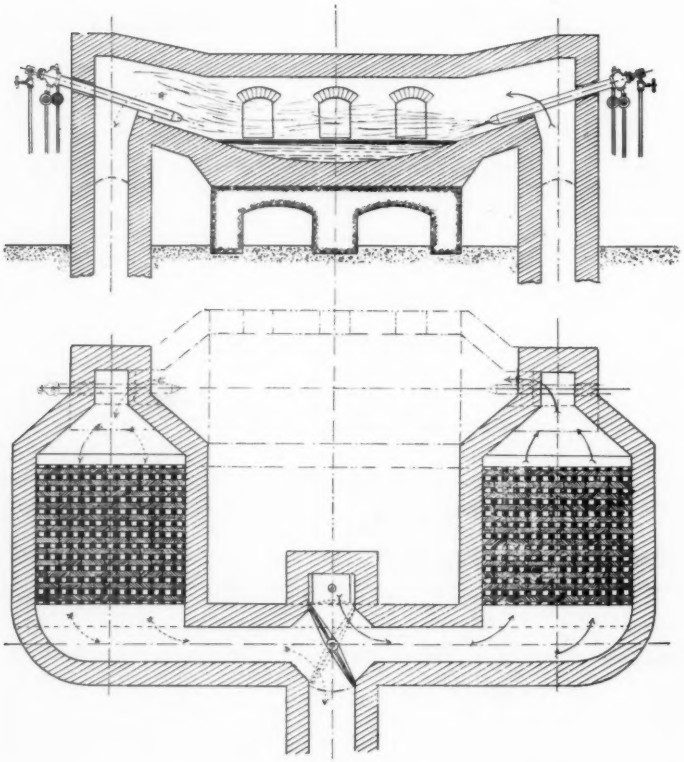
With Remarks on the Small Open-Hearth Furnace.

BY W. M. CARR, NEW YORK CITY.

It is a fact that the open-hearth process for the manufacture of steel is gradually gaining ground, as can be proven by statistics. The reason for its supplanting other methods is mainly one of quality. Further the basic open-hearth process permits a mixture of pig-iron and miscellaneous steel scrap of a lower grade and cheaper price than raw material necessary to other processes.

With the foregoing facts in minds the author presents this article for the consideration of prospective investors in the manufacture of steel castings in small, moderate and large tonnages, (or to be more explicit, small tonnages are capacities of melting units in one-half, one and two tons per heat. Moderate tonnages are capacities of furnaces

of two to five tons per heat, and large tonnages are capacities from ten to twenty-five tons per heat.) There are thus offered



possible outputs to meet almost any requirements.

In presenting the claims it is with the recognition of the fol-

lowing advantages:

1st. The small capacity furnaces cost less to install than any other steel making devices excepting only crucible melting furnaces.

2d. The economy in operation of open-hearth furnaces in any capacity over that of any other steel making process.

3d. The certainty of results, the greater degree of control in operation and the reduction of the *personal equation* to the lowest possible expression.

It is generally known to the foundrymen that the largest production of steel castings comes through open-hearth furnaces of capacities of five to twenty-five tons per heat. Such practice is established and requires constant demand to be profitable, and investment of considerable capital varying with the size of the plant. It has been thought that capacities of less than five tons per heat are not possible by open-hearth methods, and engineers generally have dissuaded those who wish to engage in the manufacture of steel castings either for their own consumption or the trade from using open-hearth methods, since up till quite recently the tendency has been rather to increase the capacity of the open-hearth supposedly for economical reasons rather than to build small units with less capacities.

The author, however, has had the opportunity to demonstrate the possibilities of the miniature open-hearth and has found from actual practice that they are economical, and comparing operation costs with standard capacity furnaces bear equally well in economy. This fact is somewhat of an innovation, but nevertheless true, and it can be said that the operating cost of the miniature open-hearth is less than that of any type of steel producing unit or process making steel in equal quantity.

To assist those who may not be familiar with an open-hearth furnace and its operation a study of the diagram herewith given may be instructive. The upper part of the furnace is represented in sectional elevation. The structure is built of refractory bricks and bound securely with structural steel beams and plates at certain points not shown in the diagram. The lower part of the furnace, usually below the charging floor level or carried below the shop level, consists of the regenerator chambers, con-

necting flues leading to a reversing valve and thence to a stack. Referring again to the main body of the furnace will be noticed the hearth, which is practically a shallow dish lined with "silica" sand fused into one solid mass at a high temperature at the time of what is known as "making bottom." This is the laboratory where the raw material is melted and refined to steel of any desired composition. In outline the practice is as follows and refers to the operation of a miniature open-hearth fired with fuel, oil recommended in preference to producer gas in capacities of less than five tons per heat.

After the furnace has been brought up to a working temperature, a white heat, a mixture of acid pig-iron and low phosphorus steel scrap in usually the following proportions, one-third pig and two-thirds scrap, is charged into the furnace, adding the pig-iron first, and when that becomes molten, followed with the scrap. The whole mass subsequently becomes liquid by means of the oil flame passing above it. At this stage the temperature of the furnace has been lessened through the addition of the cold stock, but it will still be a temperature above that required to melt pig-iron. But in order to elevate the temperature above that required to melt steel and have it in condition to pour the advantage of the principle of regeneration is available, which consists in returning to the furnace waste heat which in other types of furnaces escapes to the stack. Without a system of regeneration it is not possible to reach a proper steel casting temperature, that is to say, a reverbratory furnace without regeneration gives a temperature, where the combustion of the fuel is supported by *cold* air, less than that required to properly liquify steel, but with the principle of regeneration applied to such a furnace high temperatures are readily reached.

To understand this principle we will follow the course of the flame of the burning oil as indicated by the arrows in the diagram. Beginning at the right hand end oil is delivered to the burner which is shown surrounded with a water cooled casing to protect the burner fittings. The oil is delivered either by gravity or pump pressure, but before reaching the end of the burner it is atomized or vaporized by air under pressure.

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This air is designated as primary air and performs little or no part in supporting combustion of the oil vapor, and the quantity of air delivered in excess above the amount necessary to promote combustion of the oil is known as secondary air. The secondary air enters the reversing valve shown at the stack connection, passes through the right hand regenerator, enters the uptakes below the water cooled burner casing, performs its function and passes along the roof of the furnace, in part, and the remainder, mixed with the products of combustion with the strata of flame playing above the bath, enters the downtake at the left hand end of the furnace and in their passage to the stack give up the major portion of their heat to a large quantity of brick work piled within the chamber. When the waste gases have passed through the reversing valve and entered the stack they have just about enough heat to induce the necessary draft. Now, after an interval of twenty to thirty minutes the right hand burner may be shut off, but not withdrawn from the furnace, the reversing valve is thrown and the oil and primary air turned on at the left hand end of the furnace. The secondary air will then be diverted by the reversing valve to flow through the left hand regenerator or checker chamber, and passing through innumerable passages in that set of checkers absorbs large volumes of heat radiating from the glowing bricks which became heated in the first instance by the outgoing gases during a previous cycle of operation. This radiated heat regenerating the secondary air will be added to the temperature generated by the burning fuel and the products of combustion will accordingly have an increased quantity of heat units to deposit in the checker work at the outgoing or right hand end. In other words whatever temperature may be carried in by the secondary air will be equivalent to an increase in efficiency of the burning fuel. Successive reversals of the fuel, primary and secondary air produce constantly increasing increments in flame temperatures short of the melting points of the refractory brick works.

We have seen what can be accomplished by storing up and restoring to the furnace waste heat from the products of combustion producing the effect of a higher possible temperature than in any type of melting furnace. In addition to this effect

another one is quite active and that is reflection of heat from the walls and roof of the furnace upon the surface of the bath of metal. This latter effect known as radio-activity is more pronounced in a narrow melting chamber than in a wider, and consequently the result will be two factors, one a decreasing fuel consumption and the other the possibility of superheating steel in a miniature open-hearth. This fact has not been recognized heretofore since most open-hearth furnaces are fired with producer gas, and since that fuel requires peculiar furnace construction to get the best results in burning it, it has not been found possible to make use of such fuel in a comparatively short furnace hearth and therefore all furnaces designed to use that fuel must have a comparatively long hearth tending mainly in the direction of increased capacities rather than decreased. On the other hand the length of the hearth is not restricted where oil can be substituted for producer gas and therefore it has been found possible to operate an open-hearth furnace as small as 350 lbs. capacity per heat. Thus a new field is opened to make steel by the open-hearth process.

Referring again to the operating method, we saw where the bath of metal was molten and at a moderate temperature. This temperature was due to the fact that the metal was highly carburized, since the presence of carbon lowers the melting point of iron. We saw how it was possible to gradually increase the temperature of the furnace by the regeneration of the secondary air, and with that constant elevation of temperature, dormant chemical actions will be set up. The first effect will be an oxidization of the silicon occurring mostly on the surface of the metal by the oxidizing action of the flame. The product would be silica which combines with whatever oxide of iron might be present in the bath of metal. The combination would form a slag of comparatively light weight that would rise to the surface and cover the bath. The slag is shown in the diagram by the heavy black line. This layer of slag prevents the metal below from direct contact with the flame. After the removal of the silicon the next action will be the removal of the carbon. This action is a gas forming one and will cause a bubbling or boil throughout the bath. The action can be augmented from time to time by the addition of iron oxide in

the form of iron ore. As the decarborization progresses test plugs are taken from time to time, the operator judging the amount of carbon in the bath by their fracture and malleability. When the carbon has decreased to a predetermined point, the boil may be stopped or killed by deoxidizing agents such as ferro-silicon and ferro-manganese in properly weighed amounts. The metal can then be transferred to molds. This method as outlined refers to the Acid Process. In it the elements Sulphur and Phosphorus are not removed. The Basic Process consists of a hearth lining made of magnasite. Such a lining permits an addition of limestone to form a slag which will absorb the two elements and make a purer steel, chemically speaking, than the Acid Process, and at the same time allow the use of cheaper and irregular composition raw materials against the Acid Process with strictly limited chemical composition concerning the two elements mentioned.

With open-hearth furnaces designed to use producer gas and which rarely go below five tons capacity it is not possible to adapt them to intermittent operation. Even in the smaller producer gas fired furnaces the roof span is considerable, resulting in heavy stresses on the side walls and binding. These stresses will vary as the furnace may be heated and cooled, and if such alternations are frequent there is danger of collapse of the furnace. It becomes necessary then to maintain them at a steady temperature continuously. Unless there should be demand for regular tonnage the fuel consumption during idle periods would be a constant expense.

In miniature open-hearth furnaces, owing to the comparatively narrow hearth chamber, the roof span is of course lessened and therefore whatever expansion or contraction there may be following heatings and coolings, will result in comparatively slight stresses, and these results decrease in effect with the lessened capacity furnaces, and they therefore lend themselves with greater ease and lessened liability of repairs to intermittent operation. The miniature open-hearth is most satisfactory in the rolling type with the body cylindrical, so that the stresses even though slight will be evenly distributed, whereas in a rectangular form the roof will always rest and thrust upon the inside walls.

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In fact the miniature open-hearth is not recommended to be built in the stationary type.

In conclusion the miniature open-hearth is not costly to install, is comparatively simple to operate, gives results equal to standard open-hearth practice, makes hotter steel than the regular open-hearth and can show costs equally as low per lb. of molten metal in the ladle.

American Foundrymen's Association

THE USE OF PULVERIZED COAL FOR FOUNDRY PURPOSES

BY RICHARD K. MEADE, NAZARETH, PA.

The use of pulverized coal in place of producer gas and oil for heating furnaces of all classes has grown very largely during the last 10 years. At the present time, it is safe to say that approximately 2,500,000 tons of coal are burned annually in the pulverized condition. This form of fuel is used almost exclusively for the heating of rotary cement kilns and furnaces for the nodulizing of fine iron ores, the only exceptions being in localities where natural gas is available or where fuel oil is cheaper than coal. Powdered coal has also been used for the heating of furnaces for malleable castings and annealing.

The subject is one which has not received the attention from metallurgists and foundrymen which it deserves. The use of pulverized coal offers many advantages over gas heating, not the least of which is the economy. Where coal is converted into gas there is always a certain loss due to the complete combustion of a part of it to carbon dioxide and also to the fact that some heat is lost by radiation and some coal is carried away unburned by the ash. It has been estimated that the losses of

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the producer are seldom less than 20 per cent. and generally average about 30 per cent. of the thermal value of the coal. Where pulverized coal is burned, on the other hand, the coal is injected into the furnace and is entirely burned there in direct communication with the charge. The entire number of heat units in the coal is liberated in the furnace and consequently the whole amount of heat is produced where actually needed.

Another advantage which is to be met with in the burning of pulverized coal is in the fact that it may be burned with almost the exact theoretical quantity of air necessary for complete combustion. Frequent analyses made upon furnaces fired with pulverized coal show that the excess air can be easily reduced to 20 per cent. of the theoretical quantity without having more than 0.1 or 0.2 per cent. carbon monoxide in the waste gas. If a reducing flame is desired it is easily possible by diminishing the quantity of air admitted, to produce a flame of the latter quality.

Coal dust heating is particularly well adapted to obtain high temperatures in open hearths and furnaces of this character. It is possible by using powdered coal to obtain a very much higher temperature than can be done by the use of producer gas. For instance, with ordinary good gas slack it is easily possible to obtain a temperature of between 1,800 and 2,000° C, while with producer gas without regeneration, it is seldom possible to obtain a temperature within three or four hundred degrees of this.

It is also possible with powdered coal to obtain just as long a flame as can be obtained with producer gas. By varying the draft and consequently the amount of air brought in with the coal, and the fineness of the latter it is easily possible to draw the flame entirely through the furnace into the stack. We have even seen the brick of the stack slagged where the flame had been allowed to go the full length of the furnace. It is also possible to concentrate the flame within a very short zone. In a rotary cement kiln, 60 ft. long, by the use of a damper consisting of a door at the foot of the kiln stack, it is possible to obtain a flame which will reach either the entire length of the kiln or else be concentrated in the first 20 ft.

With pulverized coal it is possible to obtain a very regular heat, much more regular than can possibly be done with producer gas. The latter is very irregular in its composition, even where

the producers are very carefully handled, while with the coal the composition is usually very constant. If the coal is fed to the furnace at a uniform rate and the air admitted to the latter through an opening of definite area, the temperature will remain practically constant, other conditions remaining so.

Another advantage which is met with in pulverized coal firing is in the use of low grade fuels. Many coals may be burned in this manner, which would slag so badly if burned on a grade that the producers or furnace would have to be entirely shut down to remove the clinkers. The table below gives some analyses of coals which have been burned in the powdered form. As will be seen, most of these coals are high in volatile matter and these are best for pulverized firing. It is possible, however, to burn coals very much lower in volatile matter than those given in any of the above analyses by pulverizing the coal very finely.

ANALYSES OF COALS USED FOR BURNING IN POWDERED FORM.

	Moisture	Volatile Combustible Matter	Fixed Carbon	Ash
Wellston, O.	2.94	41.96	42.82	12.27
Fairm't, W. Va.	1.38	35.04	56.03	6.27
Connellsville, Pa.	2.15	34.20	57.49	6.16
Illinois	7.50	30.70	53.80	8.00
Alabama	0.82	33.76	61.57	3.85
Hocking Valley	6.59	34.97	48.85	8.00
Poor quality, Pa.	2.10	29.63	51.28	16.99
Poor quality, Pa.	2.32	27.08	47.34	23.26

Another saving which is effected by the use of pulverized coal is in the doing away of the necessity of very tall stacks in order to provide draft sufficient to draw the air through the fuel bed. This draft is always more or less an uncertain quantity, owing to the fact that it varies considerably with the nature of the coal used. With pulverized fuel all that is needed is sufficient draft to carry off the products of combustion.

The three questions which are oftenest asked in connection with pulverized fuel is; what becomes of the ash? What is the danger of explosion? And what is the cost of the process, both for installation and operating expenses?

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With respect to the first question, what becomes of the ash, it may be said that the ash of pulverized coal is very light and that a great deal of it is carried off by the strong draft which exists in most metallurgical furnaces. There need never be any apprehension, however, that sufficient of the ash will settle on the charge to insulate it and prevent the heating of the latter. Where regenerator furnaces are used, however, to heat the air for combustion, the ash, of course, may collect in the checker work of these. Where pulverized fuel is used for burning, therefore, the regenerators should be designed with large ash settling chambers and wide passages in the checker work. The latter should be also so fixed that they may be cleaned out with a jet of compressed air. As we have said it is possible to obtain much higher temperatures with pulverized coal than can be done with producer gas. It is probable that in many instances the regenerative furnaces could be left out altogether and that pulverized coal would still show as good economy as producer gas. The amount of heat introduced by preheating the air necessary (10 lbs.) for the combustion of 1 lb. of coal is never more than 4000 B. t. u., which just about balances the loss in the producers in gassifying 1 lb. of coal.

It happens that if the flame is projected directly against the wall of the furnace that the ash will slag the latter and very soon eat it away. The best plan therefore in heating these furnaces is always to direct the flame so that it strikes against either the charge or else the slag upon this. In all furnaces in which the metal is protected by a slag above no apprehension need be feared as to the ash, as by directing the flame against the slag, the ash will fall into this and be taken care of.

In coal dust firing the best results are obtained by injecting the material against a hot surface such as a molten charge or the hot walls of the furnace. In starting a recently charged furnace where the walls of the latter are incandescent, it will therefore usually be necessary to direct the flame for a few minutes against the hot sides of the furnace until the coal dust ignites. It can then be turned down upon the charge.

With respect to the second question, the danger of explosion. This has been very largely magnified. Pulverized coal in a pile burns very slowly and with absolutely no explosive effects. It is

only where the coal is stirred up and suspended in the air that explosions occur. They also occur very much more frequently in badly ventilated buildings. To guard against explosions the building in which the coal is pulverized should be provided with ventilators in the roof to carry off any gas which accumulates. Electric lights should be used throughout the building, and no workman's torches should be allowed in it at any time, whether the mill is running or not. With a little precaution firing with powdered coal may be considered as safe as firing either with producer gas or oil.

As to the cost of preparing the coal, a great many improvements have been made of late in grinding machinery, and materials of all classes may now be pulverized at a much lower cost than formerly. Where small quantities of coal only are needed, any of the wind pulverizers upon the market such as the "Areo or Stroud" will give fairly satisfactory results. Where quantities of coal approximating 40 or 50 tons per day are to be burned it will always be found more economical to install a good fuel plant. Such a plant would consist of a rotary cylindrical dryer through which the coal is passed to free it from its moisture. The dryer is followed by either a pot crusher or a set of rolls which are designed to reduce the coal to a size of one-half inch and under. The pot crusher may be followed by a Fuller-Lehigh mill. This mill is very economical of power and has a large output compared with the energy necessary to run it. These mills are practically dustless, take up small floor space, and are hence well suited to coal pulverizing. A mill of this type will grind from 150 to 200 pounds of coal per H. P. hour bringing the coal to a fineness of 92 per cent. passing the No. 100 mesh sieve.

The cost of a plant for preparing 100 tons of coal per day will be approximately $17,000. A plant for the production of one-half this quantity would cost about $10,000. As to the cost of preparing the coal itself, a plant preparing 100 tons of pulverized coal per day would cost about $30 per day for running expenses, labor, power, coal for drying, repairs, fixed charges, etc., which would make the cost of preparing the coal 30 cents per ton. This is a liberal figure.

As to the method of burning the coal, this is usually done by means of a form of injector together with a fan. The coal itself

XUM

is usually brought from the fuel mill by means of a screw conveyor and stored in a large bin near the furnace. It is drawn from this by means of a screw conveyor. This conveyor is actuated by some form of speed controller and the amount of coal fed to the furnace may be regulated very closely by the speed at which this screw conveyor is run. The coal from the conveyor drops down in front of a blast of air from a fan and is carried off by this into the furnace. Only about 20 per cent. of the air necessary for combustion is burned with the coal.

A great many foundries and metallurgical works have installed apparatus for burning pulverized coal. In most cases they have had more trouble with the process used for pulverizing than with the actual use of the coal itself, This has in almost every case been due to the fact that the machinery which they installed was of a cheap and inefficient form usually of the hammer and wind type. By the employment of good machinery, properly installed, the pulverizing part of the proposition becomes a very simple one.

As to the actual results obtained at various foundries, it is almost an impossibility to get any reliable figures. Even from several plants with the installation of whose grinding machinery the author of this paper has been intimately connected, it has been very hard for him to obtain any information. The conclusions drawn above, however, have been verified by the results obtained by one large foundry using powdered coal for the firing of its heating furnaces.

In conclusion it may be said that the subject is one of such splendid possibilities that it is strange that metallurgical engineers have not given the subject very much more attention. In the cement industry, fuel oil was first used. As the expense of this increased it was necessary to find a cheaper fuel. Producer gas and pulverized coal were both tried. With the former it was found impossible to obtain the proper temperature without the employment of some form of regenerating oven. With pulverized coal on the other hand no difficulty was met with in obtaining temperatures very much higher than those needed in the cement kilns; namely, about 3000^0 C. Now practically all the

Portland cement burned in this country is burned in rotary kilns. They have been used for heating metallurgical furnaces at a number of plants, and it would seem that the up-to-date foundry could employ pulverized coal to great advantage.

American Foundrymen's Association

CONTINUOUS MELTING *

BY RICHARD H. PROBERT, LOUISVILLE, KY.

In the continuous melting of iron in our foundry we operate two cupolas alternately. They are situated side by side, midway and at one end of the molding floors. They were made in our own shops, are drop bottom and of the same size and type. Their dimensions are as follows:

Height over all 30′—6″
Inside diameter (lined) 30″
Size of charging door 1′—6″x2′—4″
5 tuyers 4″x5″ each.
Air or blast box 6″x2′—4″ high
Melting zone is 8″ above the tuyers and extends up for 20″
From the bottom to charging door 9′
From the top of charging door to top of stack 19′
From bottom to slagging hole 12″
From bottom to tuyers 20″
Outside diameter of stack 42″
Outside diameter from charging door to top of air (or blast) box 56″
Outside diameter from top of air (or blast) box to base 68″

The stack is lined with regular stock fire brick and from the charging door to the bottom is lined with cupola blocks 4″ thick, 6″ wide, 6-⅞″ inside radius and 9″ outside radius. These blocks and the fire clay used with them are of the best make. From which we get excellent results. They are guaranteed to stand over 3000 degrees Fahrenheit, are dense, hard, tough and very

* This paper is presented and read before the Ohio Society of Mechanical Electrical & Steam Engineers, at Canton Ohio, and the American Foundrymen's Association at Cincinnati, Ohio, at their meetings in May, 1909.

refractory, made from flint clay high in alumina. It is economy to use high grade material for lining from bottom to charging door, especially on continuous melting, as previously, the repairs, were very considerable over and above what it now costs—in fact over double. The space between the shell and the lining is filled with grout. The last lining put in from the charging door to bottom was on November 2d, 1907, and it is still in good condition.

CUPOLA CHARGING.

In addition to our continuous melting we make gray iron castings for machine, structural and other lines of work, which is put up on the regular sand floor. These castings are poured each morning before the continuous work is begun. The night watchman lights the cupola at 6 o'clock A. M. everything being got in readiness the previous evening. The first iron is tapped out at 7.20 to 7.30 A. M. The first charge of coke to heat up and form the bed amounts to 500 lbs.; we previously charged 900 lbs., but successfully reduced it to 500 lbs. Our charges are small in comparison to those of general foundry practice but owing to the nature of the work and the continuous melting, the charging of the cupola and frequency of the metal tapped out, all requires nice adjustment to prevent loss.

MELTING.

The charge consists of 100 lbs. of coke and 500 lbs. of iron (about as follows: 100 lbs. Machinery Scrap, 250 lbs. pig and 150 lbs. remelt). The last three coke charges are usually 50 lbs., 50 lbs., and 25 lbs. Limestone will average about 2¼% to the total iron charged. On a day's run of 20 charges, limerock is commenced with the 5th heat and stopped off on the 15th. This has been closely followed up and no difficulty is experienced. Loss in melting is about 2½% deducting the finished castings and scrap cleaned up from total iron charged. Slagging commences regularly on or about 11 A. M. each day.

CUPOLA REPAIRS.

We daub up the cupola with swamp or blue clay mixed with fire-clay. The melting zone and bosh is repaired with one part swamp clay and two parts fire clay, with small crumbs of fire brick.

SAND BOTTOM.

Sand bottom is made up from the siftings of the previous bottom, tempered with three shovels of new molding sand, slightly dampened and riddled. The bottom is stamped and rammed close with a close joint of fire clay around the edges. We make up the bottom as dry as possible, which is the best practice for small heats, as it does not chill the iron when first melted. The thickness is 3-½" at the level of the tap hole and slopes to 4-¾" thick at the back, this will give a slope of ½" to the foot. Figuring inside measurements, the slag hole is 8" above the sand bottom, from the slag hole to the bottom of tuyers is 9" and from the top of tuyers to the bottom of melting zone is 8" with melting zone extending up about 20".

BREAST.

The breast is made with a fire brick, chipped, grooved, and beveled on the inside to one inch in thickness at the bottom side. The groove forms the tap hole, this brick is set in place with fire clay. The spout is lined with two fire bricks end to end and grooved or channeled out, fitted, and daubed smooth with fire clay.

BLAST.

The blast pressure equals 6 ozs. and is regulated with a swing valve. The wind intake is 10"x10½"= 105 sq. in., which exceeds the tuyers 5 sq. in.

COKE.

All our coke is kept perfectly dry being unloaded direct from the cars into storage bins built inside the foundry at the foot of runway to the cupola. Coke analysis:

Volatile Matter	0.67
Fixed Carbon	87.05
Ash	10.60
Sulphur	0.74
Phosphorus	0.016

FRAME RUNNING.

It is very important that the molding frames and molds be kept up to the highest state of efficiency so as not to cause delay in the pouring and the holding back of the iron in the cupola. The frame and mold capacity should always be greater

than the pouring capacity, which will permit of continuous work. The cupola tender must strictly watch his charges. He must not melt down too fast. The blast must be regulated so the heat is at all times fully known to him. He should keep in close touch with the work on the foundry floor and be ready to give or slack his metal as it is required by the men. Good common sense and strict attention to his duties are required to prevent chilled heats, over heating, and other losses. Slagging commences regularly each day about 11 A. M. The slag is allowed to accummulate until just below the tuyers. Our experience is that by leaving the slag to this height we get cleaner iron and better results from the blast. We open the slag hole just enough to let the slag run and by letting this gather in a crust on the outside of the slag hole, it acts as a trough and prevents the blast escaping out with the slag.

MOLDING FRAMES.

The molding frames for the permanent molds are either square or rectangular in form but should always be carefully designed so the molds can be arranged on the frames to the best advantage for the work to be done. They can be made with flat bar iron cross and intermediate bars fastened to cast iron frame with solid cast iron trunnions on each side, or a frame work of angle iron with cast iron trunnions bolted to the sides with flat bar iron cross pieces to angle of frame work. This makes a much stronger frame. The molding frames are supported on cast iron stanchions set securely in an upright position in the molding floor, the top of each stanchion is made with an open bearing or journal fitted up to take in the trunnions on the ends of the molding frames. This allows the molding frames to revolve freely on the trunnions, as in operating a number of molds on one frame the pouring of the molten iron can not always be done from the same side of the molds, the gates do not run in the same direction, consequently, some of the molds must be poured from the opposite sides to the others. The revolving frames can be turned to the best position and quickly fastened in place with a plain steel pin set into holes drilled in the end of one of the trunnions, to a lug or bracket on the stanchion below the bearing. For some work the molds on one side of the molding frame are much heavier and larger than those on the other side,

which causes the frame to be top heavy and difficult to handle. This can be easily overcome by an arrangement of counter weights, adjusted so as to properly balance the frame. A circular revolving molding frame is very convenient and can be worked to advantage on standard lines of duplicate work, in which the molds are self-contained and separate unto themselves. Such an arrangement would permit of the iron pourer getting around his work quickly besides leaving sufficient room for more than one man to pour iron on the job at the same time.

PERMANENT MOLDS.

Our permanent molds are largely ornamental, some of them are made to hinge and are provided with a swivel clamp set into a lug on the side of mold for fastening the two halves together, others are not hinged and are fastened together with screw clamps or gib and key. Any arrangement made for the fastening of the mold together should be made so the same can be taken apart easily and quickly, as it is necessary to open up the molds as soon as poured, in fact while the casting is at a very bright red heat.

Castings that are unequally proportioned and uneven in their different parts will crack open and chip if allowed to cool in the molds. The molds are machined on the faces that close together so as to make a tight even joint, they are also machined on the bottom side that is bolted to the molding frame. They are drilled and tapped with the hinge pin properly fitted, so it is necessary to have them soft enough to permit of this machine work and fitting being done and still be tough enough and of the right grade of iron to stand up to the molten metal continuously poured into them. If they fail to do this and burn out quickly it is quite a loss of time and expense, delay in producing the work and the expense of remaking the molds. After some experimenting the writer found that molds with the following analysis gave fair results:

Sil.	Sul.	Phos.	Mang.	Com. Carbon	Graphite
2.15	.086	1.26	0.41	0.13	3.17

Molds made from iron with this analysis were worthless:

Sil.	Sul.	Phos.	Mang.	Com. Carbon	Graphite
3.30	.057	0.67	0.12	0.19	2.98

Molds that gave the best results were made from two special

brands of No. 2 Foundry pig (see their analysis marked No. 1 and No. 2). Heavy machinery scrap and our regular No. 2 Foundry pig.

No. 1. Sil.	Sul.	Phos.	Mang.	
1.50 to 1.75	.015 to .03	.18 to .20	.60 to .90	STRONG IRON.
No. 2. Sil.	**Sul.**	**Phos.**	**Mang.**	
2.25 to 2.75	.015 to .03	.40	.45	FLUID IRON.

The charges were made up from:

150 pounds of No. 1 (analysis No. 1)
75 " of No. 2 (analysis No. 2)
100 " of our regular No. 2 Foundry pig.
200 " of Heavy Machinery Scrap.

525 pounds Charge.

The analysis of the molds cast from this mix was:

Sil.	Sul.	Phos.	Mang.	Combined Carbon	Graphite Car.
2.02	0.07	0.89	0.29	0.84	2.76

These cast molds are easily machined and do not burn for a reasonable length of time. Extra care is taken in molding them. We have success in using a molding sand made up from

8 parts of old floor sand.
3 " of new Floor sand.
1 " of Sea coal facing.
1½ " of Sharp Sugar Sand.

This with plumbago, a good parting and setting in the pattern again together, with careful melting by cupola tender, has given us the best permanent molds to date.

HIGH CARBON STEEL MIXED WITH MOLTEN IRON.

Iron was taken from the above given charge, and 7% of tool steel turnings (fine lathe turnings) were mixed in the ladle and well agitated before being poured. The cast permanent molds from this are standing up well but have not yet had sufficient time to thoroughly test this mixture.

QUICK OPERATION.

Continuous melting can be easily arranged for and with an equipment of over head runways and hoists, the frames can be quickly changed. The molds on all frames can be previously gotten ready by the mold makers, so that very little time is lost in changing frames. It is advisable to have a few extra

sets of stanchions for all preparatory work to be set up on them, thereby preventing delay.

STICKING OF IRON IN MOLDS.

A mixture of linseed oil and powdered soap stone or oil and graphite swabbed on the molds and gates each heat will prevent the castings sticking and prolong the life of the molds. The molds should be kept clean and when not in use stored away on shelves convenient to the molding frames. All our molds are classified and indexed in a Mold Book just as a well arranged Pattern Storage Loft.

STEEL MOLDS.

We use high carbon steel molds that have sharp, thin edges on their inside. In constant use the steel in these molds roughs up, but does not eat away and burn off as the cast iron molds.

CASTING SPECIALTIES.

By this process, with the proper mixture of metals carefully melted, and well made permanent molds that will stand up to to the work required of them, with instant effective pressure on the molds as soon as the molten metal is poured into them, cast specialties can be made with increased strength. The pressure will make them non-porous, more dense in structure, which the annealing would not weaken but rather toughen. Subjecting some cast specialties to pressure would make them more suitable for the finer line of machine parts, as they would be pressed into better shape, be cleaner, and with their parts more clearly defined. An equipment for such added pressure can be easily made, and after first cost would be a slight expense in operation.

American Foundrymen's Association

REPORT OF THE COMMITTEE ON PREVENTION OF ACCIDENTS IN FOUNDRIES

Your Committee begs herewith to present its final report, embodying therein the conclusions reached from a careful canvas of the Foundry Industry, so far as accidents in it are concerned, and the means possible to prevent them.

Early in the year a preliminary report was issued, which gave the total of accidents reported for the period of one year by 1,084 foundries out of the 6,336 of this country, as 5,242. Eleven of these accidents were fatal, and many of the reports in question contained suggestions on the subject which were highly interesting. Long letters were received on the importance of the subject, so that on the whole your Committee feels highly gratified with the results of their endeavor.

A great diversity of opinion exists on the cause of foundry accidents, which is but natural. The remedies suggested are varied from advice to keep a clear head during casting time, to the prompt discharge of any operative who showed the slightest tendency toward a careless disposition.

The replies received further demonstrated the fact very clearly that few shop conditions are the same, and that therefore only general suggestions can be given, leaving each foundry to deal with the problem of the prevention of accidents specially. An interesting point observed was that the fewer the employees the proportionally smaller the number of accidents. It would seem that greater attention is given the individual employee by his immediate superior than is the case where the shops are large and the conditions more complicated. This is further reflected in the seeming reluctance of managers of the larger establishments to take up seriously the deeper questions underlying the welfare of their employees, so far as freedom from accidents is

concerned. They are without question usually too busy to get to that point.

On the other hand it may as well be admitted that there is greater need of respect for shop authority, attention on the part of the employees to their own safety and that of others, and discipline and observance of rules that may be prevailing.

There is a great diversity of opinion on the part of employers regarding action in cases of gross carelessness. Some are exceedingly strict, often letting go good men on general principles,

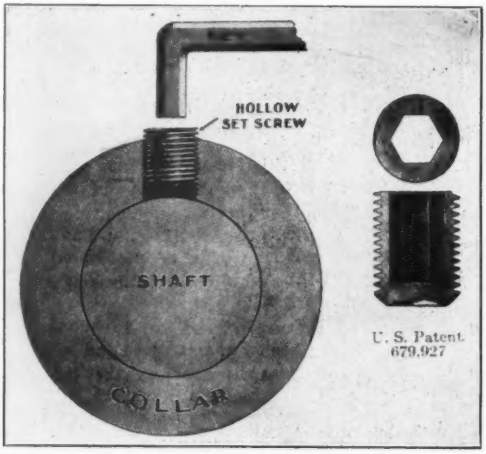

Figure 1

and perhaps unjustly so. Then again others overlook too easily and reap an unexpected reward later in damage suits.

SUGGESTIONS FOR THE PREVENTION OF FOUNDRY ACCIDENTS.

(1) Weekly or monthly close inspection of all chains, slings, hooks and ladle bows, etc. This by competent persons, properly reporting to the office. A yearly or semi-annual annealing of chains.

(2) Clean tools and an orderly arrangement of all shop

appliances. The compelling of all employees to keep everything in its allotted place when not in use.

(3) Well lighted shops. Especially on dark days and at night to have lights powerful enough to penetrate steam and dust, and yet give no sharp shadows on the floors.

(4) The use wherever practicable of tram-ways to carry molten metal from the cupola to the floors. When this is not possible, loose earth should be provided about the cupola spout, side-tapping being preferable. (This because the greatest number of accidents by burns are said to occur there).

(5) Requiring carriers of molten metal to wear the proper kind of shoes, to safe-guard their feet. Providing goggles for the grinders to protect their eyes.

(6) Prompt action in cases of gross carelessness, disobedience, and taking chances by employees.

INJURIES TO THE FEET AND NEEDED PROTECTION.

From the classification of bruises and burns contained in the reports, the latter are credited as causing the greatest number of injuries, and some foundries, in writing, went to considerable length on the question of protecting the feet. On this point a large eastern concern makes the following comments: "There is one thing which we think should always be insisted upon by every foundry manager, and that is this, that moulders should always wear boots or shoes of the type which will readily shed drops of molten metal, which may spatter in pouring off. We have occasionally found some of our molders wearing laced shoes, and have always insisted that they should be more careful in this respect." A western firm employing about five hundred men, states that "The majority of accidents were burnt feet. About a year ago, we bought some good strong shoes and made the moulders buy and put them on during the heat, and it reduced the number of burnt feet materially." A New York firm, under the head of "taking chances" report accidents caused by molten iron getting into shoes having holes or laces, and says that their men were always cautioned by the foreman, and knew their liability to accident but would not protect themselves. Again on this subject a southern concern makes the following

suggestion, "You might recommend a leather cuff to buckle tight around a moulder's leg above his shoe tops and under his pants, to keep spattered iron out of his shoes. These cuffs should flare out at the bottom and extended below the lace.

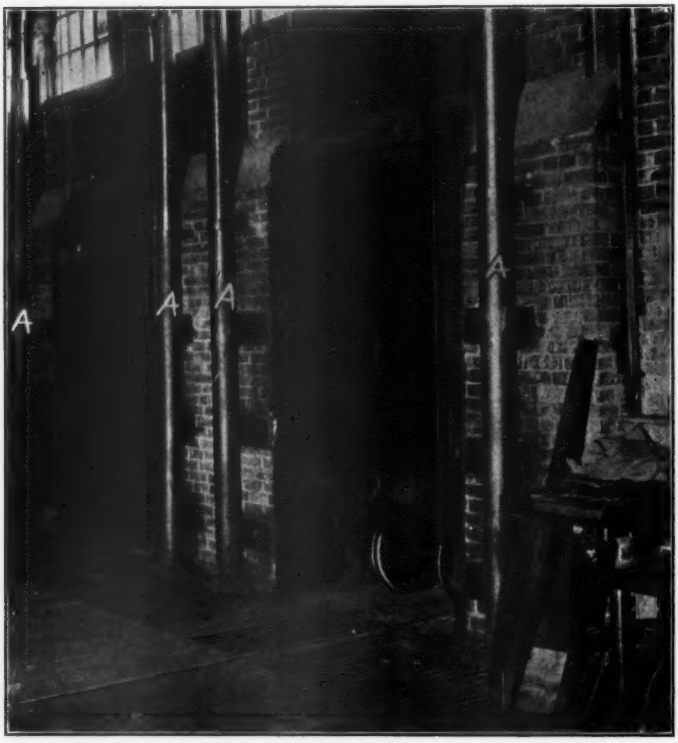

Figure 2

Burnt feet have given us more trouble than anything else."

It appears that this question of burning feet in foundries has been given a great deal of attention in Germany. One of its Societies (as shown by a reprint in "The Foundry Trade

Journal" of England), states that in collecting statistics, 247 question sheets were received, concerning as many cases of burns to the feet. Of these 244 were from melted iron. The metal came in 238 cases from ladles, and 9 from crucibles. 43 injuries took place at the cupola, 109 in carrying the iron, and 95 in pouring. Of the 247 cases of accident to the feet 17 men wore shoes with elastic sides, 21 wore long boots, 9 wore wooden boots, 4 wore buckled boots, 10 wore wooden slippers, 145 wore laced boots, and 41 wore low shoes. It will be seen from the above, that the shoes with the elastic sides, are the least dangerous, and the laced and low shoes the most.

INJURIES TO AND PROTECTION FOR THE EYES.

One Ohio firm having over five hundred employees, had in one year 140 persons who required the doctor to remove foreign material from the eyes. A Wisconsin firm, in reporting their accidents, says, "The greatest source of injury, is damage to the eyes through flying chips. The company has provided goggles, for the use of the men liable to such injury, but it is impossible to make the men use them." Another firm makes the same complaint, but aside from recommending goggles, suggests the use of heavy cast iron shields, extending over emery wheels, and bolted to the stands in such a way that sufficient space is left for the operative to grind his castings, and yet to absolutely protect him from flying pieces should a wheel break.

SAFETY DEVICES.

In taking up the question of safety devices, we feel called upon to repeat the statement of a very prominent New York Editor, who writes us as follows: "I have undertaken an inquiry into this subject, based on one of the bulletins of the Census Bureau, and am surprised to find the small number of accidents that could by any possibility have been prevented by the use of safety appliances." In keeping with this, we have a large Philadelphia concern, noted for its modern appliances which in referring to their foundry accidents state "The accidents in our foundry for the period mentioned were all such trifling burns, bruises and cuts as are likely to occur in foundry work. No safety appliance of which we have knowledge would

have served to prevent any of the accidents." In the same line another firm states "All the accidents were slight cuts or burns,

Figure 3

and of a nature which no amount of safe-guarding on the em-

ployer's part could prevent." Still further a large New York State concern says "We have every suggested device we can think of, and exercise eternal vigilence besides, we need our men, and we want to keep them safe." More along this line given by a Pennsylvania concern, which states "We always do every thing that is possible to safe-guard the life of our employees, and we welcome any suggestion which will tend to reduce the accidents in our plant. If you have any suggestions to make along this line, we would be pleased to hear from you."

A large steel foundry in Pennsylvania remarks "In addition to providing safety appliances, guards for dangerous places and keeping all apparatus and appliances in good order, an employer of labor can do much to prevent accidents by his personal efforts in training his superintendents and foreman to watch over the safety of the men under them, to the extent of instructing them in the safe use of their machines and appliances, cautioning them against taking unnecessary personal risks and in a kindly way calling their attention in the matter each time they are seen to do anything endangering their own or some other man's safety."

An Ohio firm says "Within the last year we have done away with all protruding set screws on shafts, collars and pulleys, except where not practical, in which case the set screws are covered, making an accident impossible from this source. We have also covered tumbling mill gears and pinions with cast iron guards, although the chances of an accident here are very slight, on account of the gears running out and upwards, or away from each other. However the guards now make it absolutely impossible to have an accident."

Fig. 1 shows the cut of a hollow set screw now required by law in some States. It solves the dangerous set screw problem.

In the Brown and Sharp Manufacturing Co., of Providence, R. I., in reporting their Foundry accidents state as follows, "We have taken considerable pains in our foundry to reduce the chances of accidents to as low a point as possible, and we are also sending you under other cover five photographs which illustrates what we are doing in part with this line."

"Fig. 2. Shows the doors of a core oven, which are counter-

weighted; these counter-weights run in tubes (A), so that, in case of accident, should a weight fall it will not hit an operator.

Figure 4

Fig. 3. The large ladle is in a pit, which allows us to draw off the iron into a smaller ladle, and turn it into the larger ladle to

mix, while the larger ladle is resting on a hydraulic elevator, which can be raised or lowered so that as soon as we are through filling this ladle and take it away we close the hole, and avoid the danger of a man's falling into it. In Fig. 4, "we have a device on the rail, so that when the switch is thrown to open the rail, allowing connections to be made with some other part of the equipment, the trolley is held in place, and is not allowed to pass off the end of the track. When this trolley again assumes its proper position the check is automatically thrown out of the way." Fig. 5. "We have covered our band saws in the pattern shop with a wooden case, which serves the double purpose of preventing the saws flying should it break; and at (B) an exhaust is attached, so that the dust is drawn up through the hood and away from the workman. Fig. 6. Both the saws and planers have placed before them a rubber mat, so that a person operating is not liable to slip, and here again the sawdust and shavings are exhausted through the pipe (B)."

Fig. 7 shows the difference between the unprotected and safety guarded knives of jointers. We are indebted to the Oliver Machinery Co., for these.

PHOTOGRAPHING ACCIDENTS AND KEEPING RECORDS.

A practice followed by the Lackawanna Steel Co., in maintaining a photograph department, is in such keeping with this report, that we comment here on its utility. When this company has an accident of any consequence they preserve every piece of machinery and every part of any structure exactly as it was when the accident took place. Even the men who stood near by the injured person are put in position, and the scene is then photographed while it is fresh, and every one is able to say distinctly just where he was, and what he was doing at the time of the accident. Such records are sure to be very valuable in case of any litigation. They are also very useful in acquainting interested parties with the conditions under which the accident took place, and thus afford a means of preventing them in the future. All foundries may not find it advantageous to utilize cameras for this purpose, but a complete record of an accident would be

found very useful in any foundry, no matter whether an action at law is anticipated or not.

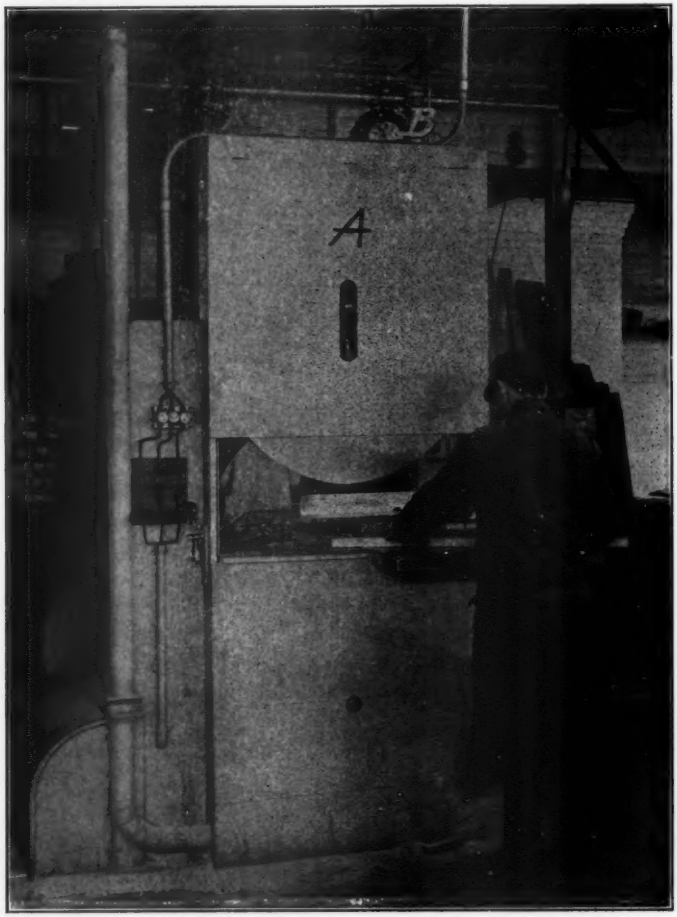

Figure 5

INSURANCE AND COMPENSATION OF THOSE INJURED THROUGH ACCIDENTS.

In the preliminary report, mention is made of $48,679.58 having been spent by 190 concerns, out of 1,084 reporting, for accident premiums. This question is receiving a great deal of attention at the present time, and it will be of interest to record here, a few selected views on the subject.

An Illinois firm having 100 employees says "We have a shop employees' insurance paying $9.00 per week for sickness or injury. This is governed exclusively by the employees themselves. This has a tendency to keep every one interested in preventing accidents."

A foundry in Ohio having 450 employees, says, "We have a benefit association into which each employee pays 30 cents a month, and is entitled when sick or injured to 5.00 per week, for 13 weeks. From July to July we paid out $1,300.00 and believe it keeps the men together."

A firm in the state of Washington, says, "It is the opinion of the writer that all manufacturers and those employing labor subject to accidents, should be classified, and all pay a certain tax, to a State fund, from which all worthy sufferers should receive a stipulated sum. The fund mentioned could be controlled and disbursed by a commissioner. Impositors sent to prison. More than 50 per cent of the damages actually paid, goes to court costs, and attorney fees, and those entitled to the benefit get comparatively little."

A long established large stove and hollow-ware Co., of Ill's says, "It is manifestly unfair that railroads, manufacturers, etc., should be held responsible for accidents to their employees. We consider railroads but common carriers, who are serving the public interests, and manufacturers do likewise. Society in general profits by these, regardless of the fact that persons enter into business for profit. Labor does not work for the love of toil, nor do manufacturers employ labor in the spirit of philanthropy. It's not a matter of sentiment, but a matter of business. In our opinion, if the law says a man's life is worth $10,000 then let each one contribute to reimburse his heirs for that amount, in the

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case of death, regardless whether the accident was due to carelessness on his part or not. The responsibility should rest on the

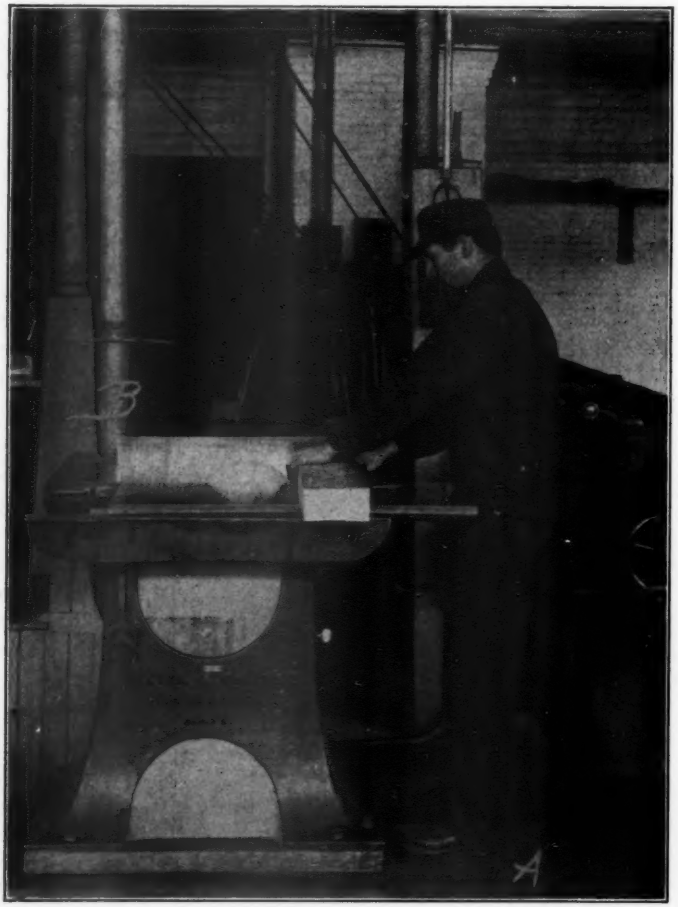

Figure 6

State, and not on the individual, and the people in general should

contribute towards the support of the same. In our opinion, it's as senseless and absurd as if a manufacturer were to be killed in his own plant, and his heirs expect the men employed in that plant to contribute their pro-rata of the $10,000 which the law now considers is the worth of a man's life. Few firms are able to stand this imposition, but fortunately these matters are carried from one court to another, until the contestants are worn out and a compromise is effected. It is all absurdly unjust, what we advocate is, that the State should reimburse the heirs, regardless of their *financial standing*, etc. What is fair for the one, should be fair for the other, and let *each man contribute his share* towards the support of 'accident insurance.' There are many phrases by which this matter may be discussed, but we feel *positive*, that at present we are working along the *wrong lines.*"

It would seem that in connection with this work, there is need for educating our employees up to seeing the necessity of every one carrying an accident insurance, and that promptly the injured be compensated by established rates of indemnity the burden being placed where it can be reliably carried with injustice to no one.

This report is but the summary of a year's work, and while having cost your committee much labor, and the Association some treasure, we feel that the results have more than repaid us. We are seeking how to prevent accidents, and as urged by your Chairman a year ago, the chief factor in getting started rightly, is to first discover the underlying causes of accidents. This done, we can apply the remedies, but not before.

A year ago no one could find a public paper or magazine in which the responsibility for accidents was placed anywhere but on the employer's shoulders. That the employee's carelesssness might have something to do with it never entered the calculation of the law-maker or editor. Today this is different, and practically the result of activity and publicity in the right quarters.

Miss Eastman, in the third part of "The Pittsburg Survey" in considering the cause of accidents, has practically adopted

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your Committee's classification, and does not lay *all* the blame as of old. This is encouraging and shows that a turn has come in the right direction. Before many years work of this kind

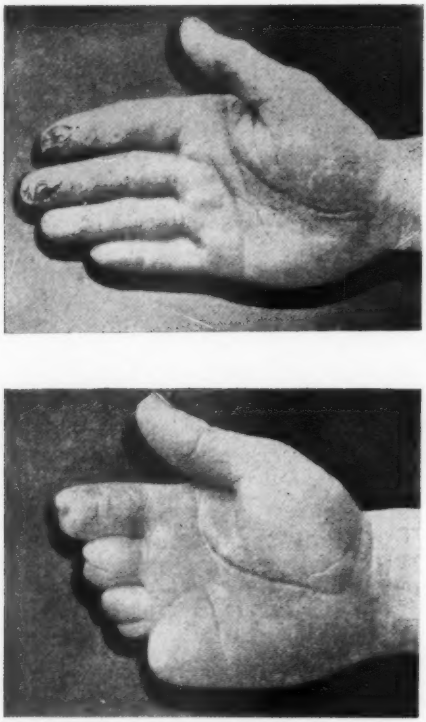

Figure 7

must help to prevent our present carnage in industrial establishments.

Respectfully submitted,
THOMAS D. WEST, *Chairman.*

American Foundrymen's Association

THE SIDE-BLOW CONVERTER FOR STEEL CASTINGS, AND ITS OPERATION

BY J. S. WHITEHOUSE, COLUMBUS, O.

The Side-Blow Converter has, I believe, firmly established itself in America, and overcome the strong prejudice which existed against it some years ago. The object of this paper is to review the difficulties of the process as the writer sees them, and explain why so many converter shops in the past have failed. When the converter was first introduced in this country claims were made for it which, to say the least, were absurd. According to the agents for the best known converter, castings could be made practically the same as in gray iron practice. With the exception of the blower for the vessel, all the equipment required was that of the ordinary iron foundry. The claim was based on the fact that the steel was hot enough to pour over the lip, and from small ladles. The next claim was that any man blessed with ordinary sense could in a few weeks learn to operate the process. The castings made in green sand were superior to castings made in open hearth by high priced men. It was not necessary to head nearly so heavy as in open hearth practice, as the liquid metal took care of the shrinkage, and it was possible to get as high as eighty per cent of castings. The objections raised by open hearth men were based principally on the heavy loss in blowing and irregularity of product.

Now, let us take up the advantages claimed by the agents, which in my opinion, have proved the greatest source of failure. These claims led a great many to rush into the steel business without any knowledge on the subject. They organized companies and voted themselves large salaries as the officers. They

then placed their order with the agents for the necessary equipment. For this equipment they paid usually ten to twenty thousand dollars, and it can be duplicated today for from four to five thousand. The rest of the capital as a rule went into buildings, engine, crane, and office furniture. Then with a balance in the bank of five to ten thousand they were ready to make steel castings and a fortune. A young man at $15.00 per week was engaged to make steel, and a foundry foreman who was a good talker hired to look after the shop.

The expert came and stayed a month, taught the young man to tell the drop of the flame and left. Everything would go fine for a few days, or weeks, until one day the charge would not blow right, then the trouble would start. The castings made in green sand were mostly blow holes when machined and the metal checked and shrank like any other steel. The steel when tested was found to be no better than acid open hearth, and in many cases worthless. The foreman blamed the bad castings on the blower, the blower on the foreman, and the management, not knowing anything about steel, condemned the process. The percentage of good castings, instead of running eighty per cent. of the charge, did well if it reached forty. The cost of castings ran about six to seven cents per pound and the selling price from four to five cents. If ten heats were gotten today from the vessel it had to be relined tomorrow. In short, in most cases, it was just a question of how much money could be lost before shutting down. In the few cases where the firm pulled through they were either wise or lucky enough to get good men who understood the steel business, and to leave them alone.

Now, as to the loss, which has been a great draw back to the converter. This is not the fault of the process, but of the inexperienced or careless operator. You would not think of putting your open hearth in charge of a green man just out of college, but in most cases this is just what has been done with the converter. The open-hearth melter is a man of experience and brains, and draws a good salary, and most steel blowers do the same today. A man may be able to tell the drop of a good blow in a few weeks, but to be a good blower he should have

at least a year's experience, as all heats do not work alike. He should have a good eye and plenty of nerve, for he will need both. He should be able to tell the temperature of his metal soon after the flame starts, and to judge the silicon by the first period. He should be able to tell if his blow is done by looking at the slag, as well as by the flame. He should know how to keep his lining in the best shape to get all the heat possible from the process, and the hundred little kinks of the trade, which, as a rule, the expert will never impart, as these are what make him an expert. The man with the above qualifications will blow with a loss of less than seventeen per cent. (about fifteen).

With proper blowing the main loss comes from the silicon in the charge, usually two per cent., which is oxidized along with iron and manganese to form the slag. The writer learned to blow with two per cent. silicon, but for the last three or four years has been blowing iron analyzing from .90 to 1.25 silicon from the cupola in two ton charges, and very often has been obliged to use scrap while blowing. Another advantage is the increase in the amount of scrap which can be carried, and which helps to cut down the cupola loss by increasing the carbon in the charge. For example: I charge fifty per cent. of pig with about 3.75 per cent. carbon and fifty per cent. scrap with .25 carbon. Tests of the cupola iron ran 3.25 to 3.50 per cent. carbon, a gain of 1.25 to 1.50 per cent. of carbon taken from the coke instead of bought in the form of pig iron. Regardless of what has been written, fifty per cent. of scrap can be melted in the cupola with good results and using only 12½ per cent. of coke, but your blower must have a complete knowledge of cupola practice.

Most blowers use too much volume and too high a pressure to get the best results, and with low silicon the volume and pressure must be low. No two blows will act alike and will require different treatment, which can be determined by the flame, but which I find impossible to describe. I believe it is as necessary for a blower to regulate his air valve to get the proper combustion as it is for the melter to adjust his air and gas valves. With ordinary care, the steel produced in a converter is very

uniform in carbon and silicon, more so I think than the open hearth. The greatest variation seems to be in manganese. The temperature of the metal and the condition of the slag causing more of a variation than in acid open hearth practice. It is possible to run several weeks without taking an analysis and find at the end of the run very little variation in the elements. This is possible in acid open hearth, but never practiced, as the risk is great, while I have known of it being done right along in converter practice.

There is much which could be said regarding the making of molds, etc., but the practice is identical with open hearth, except that the castings are for the most part lighter. The ordinary converter shop with one two-ton converter is capable of producing between one hundred and one hundred and fifty tons of good castings per month, blowing three times a week, and should not be expected to carry the overhead expense of a shop turning out five to six hundred tons, yet this has often been the case.

In conclusion, I will say that the management must be good, and the salaries paid the officers as reasonable as possible, otherwise, the shop is fore-doomed to failure, regardless of the quality of the product.

American Foundrymen's Association

MODERN CUPOLA PRACTICE

BY JOHN C. KNOEPPEL, BUFFALO, N. Y.

When we look about and see the progress that has been made in our industry of recent years, we have reason to congratulate ourselves. The fact, however, remains that our old friend "The Cupola" has not come in for as much attention in proportion, as have the other lines.

The writer has had charge of foundries for the past twenty-five years, and in the course of that time has run cupolas ranging from 36" to 60" inside diameters, and melting from five to forty tons a day. Previous to that, when with his father's foundry in New York, the melting was like in many other concerns, in the hands of the cupola-man. The result was that we had to get into harness ourselves and learn how to manage the cupola and melt our iron as we wanted it. The fuel at that time was lump coal, and chemistry in the foundry was practically unknown.

Foundry owners frequently wonder why they are having trouble with their iron, blaming almost everything but their management of the cupola. This has not received the attention that it should, and as a usual thing the cupola is considered fool-proof, in fact is expected to run itself. Good work with the cupola is first of all dependent upon a thorough knowledge of

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the cupola and its performance while working under the blast. The construction must next be such that the proper amount of air can actually get in, and in such a way that the temperature conditions are as uniform as possible, so that cold spots are avoided. The tuyere area must be of such a size and so arranged that the blast enters the cupola without undue friction.

The ultimate shape of the cupola lining, if allowed to take its own course, will be found to be slightly built out above the tuyeres, and this is an argument that if left that way, it is most desirable for efficient work. Hence in chipping the cupola and daubing up, it were best left so that only the refuse matter and iron above the tuyeres is taken away, but that this natural shape is left intact. The daubing can be very light, and cracks filled with small broken fire brick or flat brick, as the condition may require it. As the heat at this point becomes very intense, there is a tendency for the daubing to crack off long before melting is in progress. This material falls into the stock and retards melting afterwards.

Bottom is put in so that the surface while dipping from back and sides to the spout, does not fall too steep, as the melted material will run downward with too much force causing trouble in tapping during the heat. It should be so made that the iron will lie quietly on it, and not injure or break through it. The necessary shavings and kindling are now put in, the latter being laid by a man in such a way that when burning it will do so evenly, and without injury to the bottom. Coke is now thrown in and allowed to burn through evenly. When up to proper height as indicated by a wire guage or other suitable method, charging may begin.

Charging should commence at least two hours before the blast is put on, so that the stock may become well heated through, and the time for lighting up should be arranged accordingly. There should be neither too much or too little coke on the bed. Oftentimes the cupola man is allowed to take all he wants, and

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the result is a prolonged heat, with dull iron instead of the expected hot material. The iron charged should be of medium size, especially in small diameter cupolas. There should not be too many openings for the free passage or rather escape of the blast. In large cupolas while the stock can be larger, it should not be charged in too compact a way, thus retarding the blast.

The amount of the bed of fuel for a cupola is determined by a number of factors. The diameter inside the lining, the height of the tuyeres, blast pressure, class of work, etc. For light work, with practically continuous melting and pouring, the tuyeres should be set low, thus saving fuel for the bed. The bed should extend from 20″ to 24″ above the top of the tuyeres, whether one or two sets are used—above the top of the upper if the latter. On the other hand, the tuyeres must not be set too low, otherwise if any iron is to be held, it will be chilled if remaining in too long. From 12″ to 16″ from the bottom plate to the bottom of the tuyeres would seem about right for ordinary practice, the bottom being from 4″ to 6″ thick.

Slagging when the tuyeres are very low often does more harm than good, it retards melting and is destructive to the cupola lining. If the heats are heavy, so that slagging must be resorted to, it is better to put the tuyeres up higher in the first place. The slag hole should not be opened until the slag is high enough to reach it, usually ten tons or so of metal will have passed out by that time.

In large cupolas for medium heavy work, the tuyeres are usually set from 18″ to 24″ from the bottom. The higher they are set, the more fuel is required for the bed. More air must be forced through or else melting is unduly slow. High melting zones and blast pressures have a tendency to harden the iron, make more slag, and give trouble generally.

The charges of iron should be uniform, the first being as large as the last. While undoubtedly more iron could be carried on

the first charge, it would mean lowering the bed unduly with subsequent trouble, as the coke charge coming down will not restore the bed to its full height again. It is the best kind of practice to maintain the bed at its proper height at all times, and this can only be done by small and equal charges of metal and the proper proportion of coke between them.

In long heats of high tonnage, it is oftentimes a good practice to help build up the bed by adding additional coke at intervals. Experience will show this best. The writer has always had better results with such small charges. The melting was more uniform and more rapid, with hotter and better iron. With heavy charges, the melting difficulties result in giving metal with compositions different from the expected, and the chemist gets the blame which really belongs to the foundry manager.

The construction of the cupola should be such that the air entering has great volume at low pressure rather than vice versa. Good lining material should be used, preferably double up to the charging door, and single from there upward. The clay-wash should be mixed a day previous to use, and the addition of a little salt helps to tighten the joints. Space is left between the lining and the shell—about half an inch—and this filled up with a grout of old fire brick ground up, and clay. The lining at the melting zone, as stated previously is allowed to take its own shape during the heats, being originally straight like the rest of the construction. If this is done the melting capacity will be found increased. While this is the experience of the writer, he does not wish to be understood as advocating a contracted hearth construction.

The tuyere arrangement is also not considered as it should be. On one occasion the superintendent of a large foundry stated that he had cut out all the so-called fancy tuyeres and put in what he called a "cheese-box". In the course of conversation it crept out that he was having some trouble with his iron, as in some cases he lost 60 points of silicon. His cheese-box, combined with a heavy blast pressure, doubtless was to blame. Another prominent blast furnace man complains that many foundryman blows the life out of his metal in the cupola.

An experience that once happened to the writer may be of interest in this connection. An accident which took a long time to correct disabled the blower and the cupola had to be banked when in its full charged condition. It was nineteen hours before the blast was put on again, but the heat went out all right. On another occasion one of the cylinders of the engine running the blower blew out, and the cupola heat was taken off with but 4 to 6 ounces pressure on, the heat being about eight tons. The iron while coming down slower, was hotter and had better life than with the higher blast pressure carried regularly. In another case the writer was called into a foundry where they were getting out 40 tons of metal in six hours with a cupola 60" inside the lining. Here he found the coke ratio one to five for the first four charges, and a little better later on. A clear case of waste and consequent bad iron. A reduction in the coke quickly straightened matters out.

Fuel that burns up fast, such as coke, must necessarily be supplied with a sufficient amount of air in quick time. The design of the tuyeres therefore plays an important part in this. The writer has found that a continuous tuyere, of proper design, gives the most uniform distribution to all parts of the cupola furnace. The velocity of the air is reduced, and the best kind of melting obtains. When it is considered that to melt ten tons of iron about 300,000 cu. ft. of air must be admitted into the cupola for that hour, it will be seen that the tuyere conditions must be such that a minimum obstruction shall take place, before the blast actually is doing its work in the charges.

The coke below the tuyeres serves simply to hold the iron and support the stock. The temperature is far below that of the iron, and hence every pound thus used, unless for special reasons, is a direct waste. If the iron is held in the cupola too long, the blast strikes over the top and injures it. Hence, while on general principles low tuyeres are advisable, they should not be so much so that the metal is damaged when carrying out the daily practice.

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The charging door should be as high as conditions will permit above the bottom, so that the fuel will receive the benefit of the heat otherwise wasted. Ten to fifteen feet is the usual custom, though the distance is often made greater. Where a very high stack and charging door is used, it is sometimes advisable to put in an intermediate door, so that in charging the first part of the heat, the bed is not damaged. Further it allows a more even charging. This intermediate door should be sealed up when the charging has reached that point, and then the upper door is used. The charging floor would naturally have to be constructed accordingly.

In every cupola, under the same conditions, there is a fixed melting zone. Below and above this the metal can not be melted successfully. In either case the metal would be dull and damaged. This zone is determined by the cupola conditions and the volume and pressure of the blast. If the iron comes down within ten minutes of the putting on of the wind, it would indicate that the bed was of proper height. If it takes longer, then the bed was too high. The excess of fuel must be burned away, and in doing this the iron is melted slowly and comes dull instead of very hot. The melting zone is usually a space across the cupola about 4″ to 8″ high. Where the blast is heavy, this is sometimes greater. A double set of tuyeres sends the melting zone up higher than is the case with one row.

Regarding the fuel ratio this much may be said. What is economy in one foundry becomes a waste in another. The high melting ratios published are oftentimes very misleading. For general purposes 7 to 8 lbs. iron to one of fuel is very fair. With the same sized small metal charges, the coke between charges generally works out at 1 to 10. This can often be cut a little on the coke end, if the bed is ample, especially at the end of the heat. As this work should not be left to the tender mercies of the cupola man, it is a good plan to hang up a chart of sufficient size in the charging room, on which every charge is marked plainly, so that it can be followed without difficulty. All stock

should be weighed, as even the coke will not run uniform in weight if measured in a basket. This is not with the idea that the fuel should be skimped, but simply to have the conditions in charging as perfect as possible, so that the best results may be expected and obtained.

For twenty years the writer has advocated the use of small charges and as mild a blast as possible, and he is glad to note that others are beginning to agree with him. The question of the tuyeres has been his special study, and he hopes that the system bearing his name may have helped to make the work about the cupola easier and the results surer. The cupola is not merely a vessel into which any old thing can be thrown and good results obtained, but it may be come a money maker or loser just as one pleases. In these days of keen competition, it becomes a problem not only to melt iron properly and economically, but to turn out a product that will give the smallest percentage of scrap castings.

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American Foundrymen's Association

THE PERMANENT MOLD

BY EDGAR A. CUSTER, TACONY, PA.

Some twenty years ago the late Harris Tabor brought to the attention of the writer a machine for making break-shoe molds. He was very enthusiastic over it, and predicted that in a very short time all the foundries would be making their duplicate work with that class of machine. He had worked at it long and earnestly, and believed that it would win instant recognition. He lived to see the molding machine field extending far beyond his wildest dreams, but it took twenty years!

To such an extent has this feature of the founding art grown that today we have molding machines each of which costs more than the entire equipment of an ordinary foundry thirty years ago. The modern manufacturer is under the necessity of keeping down shop costs, and his constant endeavor is to substitute machines for manual labor where possible. It is this tendency that has of late years turned attention to the question of how far permanent molds may be used to reduce the cost of production. It is not a new question by any means, but the information available is very meager.

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It is the purpose of this paper to give a full and free account of the conclusions formed after three years of constant work on the problem, and if it promotes a good healthy discussion the main object has been attained. It must be understood, however, that this paper deals solely with work that is applicable to permanent molds, and the statements made, and the conclusions formed, are directed only toward that branch of the foundryman's art.

The subject may be taken up under the following heads:

(1) Of what material should the molds be made?
(2) What effect has such a mold upon the castings?
(3) What effect has molten iron upon the molds?
(4) What remedy should be applied for any bad effects shown?

These four points having been carefully considered, and the efficiency of such a mold conclusively demonstrated, the value of the permanent mold for certain classes of work is established.

The ideal material for permanent mold would be one that would not chill the molten iron, would stand swift heating and cooling without disintegration and would be capable of being machined or molded into the shape required. This material should be very nearly as hard as iron, quick to conduct heat and of low specific gravity.

There are a number of substances that fulfil these requirements in part. Lava rock will stand the sudden changes of heat and cold, can be cut into the shape desired and does not chill the molten iron. When a coating of finely ground mica, or some other inert substance, is rubbed into such a mold it will give beautiful castings. But it wears away rapidly, and soon needs renewal. Were it not for this fault it would very nearly solve the problem. We found it extremely difficult to handle and prepare this substance, and this led us to seek a material that would possess both hardness and ability to stand

the heat changes. Cast iron has been the favorite medium, and so far, nothing has been brought forward that is so well adapted for foundry work. It has the advantage of being easily machined, and the added advantage that it is formed by a process with which we are all familiar, while its possible disadvantages are more easily overcome than those of any other substance.

It is not much trouble to make and machine an iron mold, and we can calculate the expansion and contraction to a nicety. Its great drawback is its chilling effect. Some investigators make the claim that if the mold is heated to nearly the temperature of the casting when it is ready for removal, no chilling effect is perceptible; also that the molten iron should cool at the same rate in a permanent mold as it does in a sand mold. To both of these propositions I would answer that they defeat the object of permanent mold work, in that they destroy the permanence of the mold, confer no benefit on the finished product and set up a multitude of difficulties, such as core-crushing, shrinkage strains, and segregation.

But these two claims have been so persistently made that it seems advisable to treat them at some length. We are all familiar with the rapid disintegration of cast iron when kept at a very dull red heat—the rapid oxidization and the tendency to spawl and crack. When the heating and cooling is carried through a range of 200 or 300 degrees F.,—and this must of necessity occur,—the mold becomes useless in an incredibly short time. Again, the molten iron will not lay close to such a mold, and the resulting castings are far from perfect.

It has been conclusively demonstrated that mold distortions due to heat become permanent after a temperature of 900 degrees F. has been passed, so that highly heated cast-iron molds seem to be out of the question. While there is no doubt that they would prevent chilling, the cost of such a method would be prohibitive. . . . Should the iron cool at the same rate in

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a permanent mold as it does in sand? The answer to this is most emphatically in the negative. The effect on the mold would be the same as maintaining it at a high heat, and the time lost in cooling would slow the process up materially. Slow cooling would not improve the casting, nor would it prevent segregation. It would induce shrinkage strains, and in fact would be no improvement over the present sand-casting method, except that it would obviate sand ramming.

EFFECT OF MOLD ON CASTING.

When we first contemplated using permanent molds it was considered a foregone conclusion that unless the interior of the mold was heavily coated with some inert substance, the casting would necessarily be chilled, and extensive arrangements were made to prevent or to remove this chill. For a time the molds were carefully coated after each pouring, but, in our efforts to gain time, this coating was neglected, and we noticed that even when this was the case no chill appeared, provided the casting was removed above a certain temperature. Following this lead we found that when the surface of the mold was practically free of any coating, no gases were formed by contact of the molten metal, and that chill could still be prevented by removing the casting at the proper temperature. Once these facts were thoroughly established all our attention was centered on the possibility of removing the casting as soon as it was set. A few trials proved beyond doubt that molten cast iron does not chill until after the casting has set, and it was simply a question of reasonably quick work to produce castings not only perfect in form and texture but answering all the requirements for high-class marketable work.

The next step in this line of reasoning was that if the contact with comparatively cold iron on one side, did not necessarily chill the casting, then contact with iron on both sides need not

chill it. To demonstrate this point several thin sheets were cast between heavy plates and removed without chilling. This suggested the possibility of using metal cores, provided these could be removed before being caught by the shrinkage and immovably held or the casting cracked. Reasoning that cast iron does not contract until after it is solid, we believed that it would be possible to remove a core before such contraction occurred. This was tried first on the T-shaped fitting, the entire core being made of cast iron, in two parts, one part for the main body and one part for the branch. These core parts were fitted to the mold and metal was poured around them, and it proved to be not only possible but very easy to withdraw the core, provided it was done when the casting was at the proper temperature. Nor was the allowable time for the withdrawal of the core so short as would be expected. In fact, it was necessary to wait a few seconds after pouring, before removing the core.

If, then, an iron core could be easily withdrawn from a tube one foot long, it was possible that it could be withdrawn from a tube 5 feet long. This was attempted, and repeatedly accomplished, a four-inch pipe 5 feet long being cast on an iron core and the core removed before being gripped by the contraction of the pipe. We found by these trials that no gases were formed other than those from the air in the mold, and if this air was allowed free vent no trouble was experienced in filling a mold of any shape or size, and in removing the resulting casting at such temperature as to avoid white chilled crystals.

The next step was to determine what size and shape of mold was best adapted to this process. This was a long and tedious investigation, most of the results obtained being of a negative character. It is almost impossible to formulate any set rule as to size and shape of mold for various castings. The one general rule of allowing a surplus of metal in every case seems the best practice. This is, of course, very indefinite, and experience only will show what is best. The mold in which this

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trap was cast weighs 1,700 pounds, and the 2-inch tee mold confesses to over 500. The advantage of providing a large bulk of iron is too great to be ignored when it is considered that the objects desired are not only to swiftly remove the heat from the molten iron but also to provide enough metal to store this heat and resist the tremendous strains imposed.

It is to be observed that in using these molds we take no precautions against shrinkage. We depend altogether upon the fact that chilling molten iron swiftly to the point of setting makes castings that are homogeneous, and thus the shrinkage strains

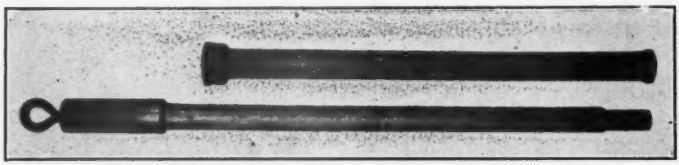

Figure 1

due to irregular cooling are reduced to a minimum. The main object to be accomplished is to secure rigidity of the mold in all its parts—there is always time enough to remove the casting and retain the shape given it by the firm, unyielding surface. A mold that has thin walls,—1-½ or 2″ thick—will spring away from the molten iron under the influence of the intense heat, and the casting will invariably follow the spring. Molten iron, like water, moves in the line of least resistance. Its peculiar property of increasing in bulk when passing from the molten to the solid state makes it possible to get a casting that fills every crack and cranny of the mold so long as this tendency to swell

is successfully resisted. This same mass of iron in the mold, by reason of its rigidity and its capacity for quickly transmitting and storing heat, will greatly lessen the liability to cracks in the mold cavity. The only place where any deterioration sets in is where the molten iron strikes in the gates, and our experience has shown that we can safely neglect this item.

How long a cast-iron mold will last has not yet been determined. So far, we have made over 6,000 pieces in a single

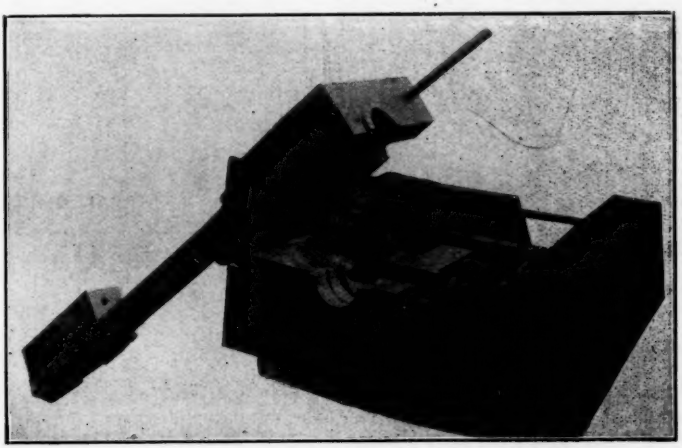

Figure 2

mold, and it is in better shape now than when we started. There is no reason why its life should not be indefinite, although there must be a point of time and service when the cast iron has reached its ultimate capacity for work. Our statistics show that the life of the mold depends, not upon the number of pour-

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ings but upon the number of times the mold is allowed to become entirely cold and then reheated. Continuous pouring, when correctly timed so as to preserve a generally even temperature,

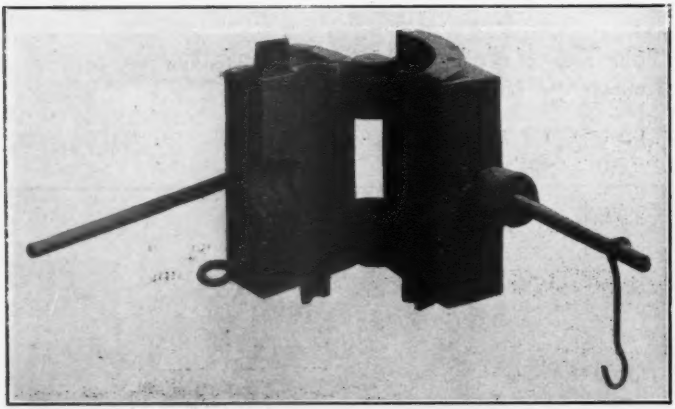

Figure 3

has but a very slight tendency to crack the mold. It is only when it is allowed to cool that the cracking becomes at all noticeable, and then only in the gates.

TEMPERATURE OF THE MOLD.

We have found that a good casting can be made in a cold mold without any trouble, provided the mold is perfectly dry. But the tendency of the iron to condense moisture from the atmosphere while heating up is so great as to make it almost impossible to get a good casting unless the pouring is done rapidly,

so that the mold will be filled before the moisture is deposited upon the face of the mold. In a perfectly dry atmosphere, with a cold mold, the iron pours readily and makes a very fine casting. The only reason it is desirable to have the molds warm is that they will then keep perfectly dry. We would much prefer to do

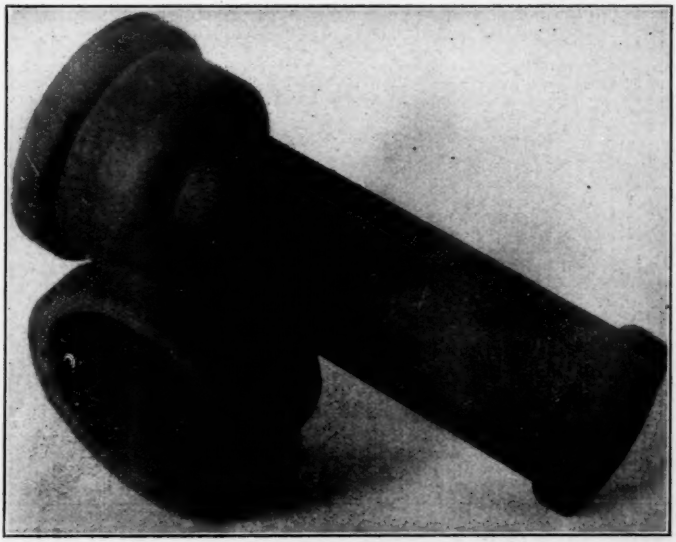

Figure 4

all our work with a mold at a temperature of not more than 125 to 150 degrees F. As a general rule the first casting is not a very good one, but after the casting has warmed up the mold, there is no further difficulty.

In order to preserve an even temperature in the mold it becomes necessary to put enough weight into it and pour the

castings at such intervals that the temperature will not rise over

Figure 5

a certain number of degrees. For instance, we found that

casting a four-inch pipe weighing 65 pounds into a mold weighing 6,500 pounds every seven minutes, does not raise the temperature of the mold to more than 300 degrees. This matter of heating depends altogether upon the thickness of the casting, and the molds must be designed with that particular point in mind.

That a permanent core can be used in a great many cases has been shown. The use of this permanent core is necessarily

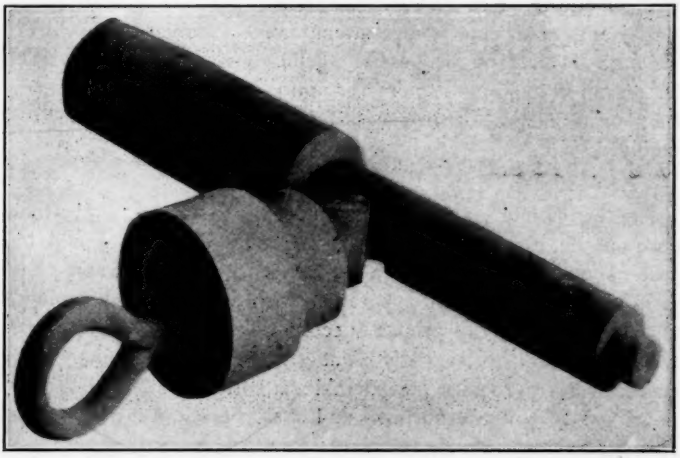

Figure 6

limited to castings in which the core is either in a straight line or is in a regular curve. Combinations of straight lines, such as in T's or Y's, or double T's or double Y's or straight pipes, are especially adapted to this feature. When the core is in the shape of a regular curve, or combination of a straight line and regular curve, it can be made in two or more pieces and easily withdrawn from the casting. This can be done in the case of

L's, or sweeps. Irregular curves or cores that would be destroyed in removing them from the casting are, of course, not possible.

We have found that the best metal for these cores is ordinary cast iron, and that the same method of procedure must be carried out for the core as with the mold. There is plenty of time to remove the core and open the mold and yet have the casting without any hard spots. The use of permanent cores suggests the possibility of a machine for duplicate work that is to be made in large quantities, and this machine can be practically automatic in its operation. Pipe fittings, chain links, elevator buckets might possibly come under this class. This is, perhaps, looking rather far into the future, but it is the logical outcome of the successful carrying out of the principle involved.

Another point: It has been found easy to remove a five-foot core in the manufacture of cast-iron soil pipe. It should be just as possible to remove a 12-foot core from a water-pipe. It is only a question of apparatus large and powerful enough, and removing at the proper speed. Cores made of steel and wrought iron have been tried, but give very poor results. The cast-iron cores require considerable attention for the first few pourings, to prevent burning and distortion, but after a few castings have been made the iron seems to become seasoned, and after 50 or 100 castings have been poured, very little care need be taken in regard to overheating the arbor or burning it by the impact of molten iron.

Soft cast iron seems to be the best medium for both molds and cores. It cracks less, and is not liable to distort, as is the case with a casting made of low-silicon or very close iron. It may be that this is due to the fact that a high-silicon iron melts at a much higher temperature than iron containing a low percentage of silicon, and consequently requires a higher temperature to reach the point at which it softens.

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The conclusions arrived at as the result of these investigations may be summarized as follows: Any casting that can be poured in a sand mold can be poured in an iron mold. If the iron is hot enough to run in a green sand mold it will surely run in an iron mold. Iron that is suitable for radiators or fittings, or brake shoes, or any other class of duplicate work that is made in the sand, will be suitable for the use of permanent molds. The same experience that shows the foundryman what is best for sand molding can be utilized in permanent mold work. It is true that a somewhat wider range of iron can be used in permanent molds for the same class of work than is the case in sand molding, but any change from the general practice in selecting irons for any particular class of work must be made with a great deal of care. It is, of course, a subject that demands close and incessant study, and every manufacturer who wishes to use permanent molds must give the same care and thought to this method that he gave to previous methods employed. When the high-class engineering and technical skill is applied to the permanent mold that has been devoted to the molding machines now in use, we may expect to see some very wonderful developments in the foundry line.

TEMPERATURE OF THE IRON.

There is one more feature that has not yet been touched upon, and that is the temperature of the molten iron. In all cases, when using permanent molds, the iron as it comes from the cupola should be very hot, and should never be allowed to stand any length of time before pouring. The first element it loses in cooling is carbon, especially if there is considerable silicon in the original charge. Iron at 2100 degrees F., with 2.5 per cent. silicon, will not hold as much carbon in solution as it will at 2400 degrees F., and it is the carbon we wish to preserve. In fact, it is almost impossible to make a very thin casting in an iron mold, with iron containing 2.75 silicon and low in phos-

phorus and sulphur, unless the iron is very hot. Our work has shown us conclusively that the best results are obtained with iron containing over three per cent. carbon and about two per cent. silicon. Again, the higher the temperature of the initial iron, the more time there is for the removal of the casting, and the longer shrinkage is delayed. The importance of *hot* iron is therefore evident, although there is but little loss of carbon when the silicon does not exceed 2.25 per cent., and ordinary diligence is used in pouring.

Some care must be exercised to prevent the casting sticking in the mold. It is sufficient to coat the mold occasionally with a mixture of thin oil and graphite. There is no virtue in any of the many coatings recommended other than keeping the molds smooth and preventing the castings from sticking. None will prevent chilling, *unless laid on in such quantities as to form a substantial wall of inert material.* The writer has used almost every available substance in an infinite number of mixtures, with but indifferent results. Mica, lithophone, clay, graphite, molasses water and clay, paraffin with any number of materials, have been tried, but one and all require a coating at each cast, which is out of the question in rapid work. A thin solution of wood alcohol and shellac, thickened with finely-ground clay, when applied to a slightly warm mold will usually prevent chill, but here again the mold must be cleaned and recoated for each casting. Silicate of soda when fused to the mold has but a very short life, and amorphous phosphorus has an entirely undeserved reputation in the line of chill prevention. The best way to prevent a chill is to take the casting away from the mold before the chill sets in.

That this chilling does not take place until after the iron has been set sufficiently to handle is demonstrated by a small sample casting made especially for the purpose. One side of this casting is soft and the other is chilled. The casting has been broken to show the effect. You will notice that the quality of the iron

in the unchilled portion is of the highest character, and the facility with which it can be machined is shown by the section of pipe on which some threads have been cut. This sudden chilling to the point at which the molten iron sets produces an iron that is as nearly homogeneous as it is possible to obtain. That it is entirely free from shrinkage strains is shown by this casting that was taken from the mold at a bright red heat and thrown into cold water. It is absolutely sound and free from all cracks, surface or otherwise.

Now, what peculiar molecular action is set up that produces this result in an iron that when cast in sand exhibits all the defects we are accustomed to see in sand molding? To get at this explanation we must begin with the great unmeasureable force of heat contraction and expansion. No one knows how many tons per square inch is exerted when molten iron cools. This force is always greater than the tensile strength of the material under treatment. If, now, molten iron be subjected to this enormous force exerted through the mold swiftly robbing it of its heat, it probably follows that the molecules are crushed together with an enormous pressure, and since this action is a matter of a few seconds at the most, there is no chance for segregation, and the impurities remain in the same relative position in the casting that they occupied in the molten iron. That this peculiar action continues after the casting has been taken from the mold is shown by the small globules of iron that have been squeezed from the casting as it cooled. It is further shown by this bar of 1⅛" iron that was taken from the mold at a bright yellow heat, with the interior still molten. The excrescences on the top were formed as the bar cooled in the atmosphere, and the broken section will show that the bar is of equal hardness throughout.

Now, let us go a step further. It has been found that iron when cast in an iron mold and removed as soon as it sets, possesses some unusual properties. For one thing it will take a

temper, and when tempered will retain magnetism. If the casting be taken from the mold at a bright red heat and suddenly

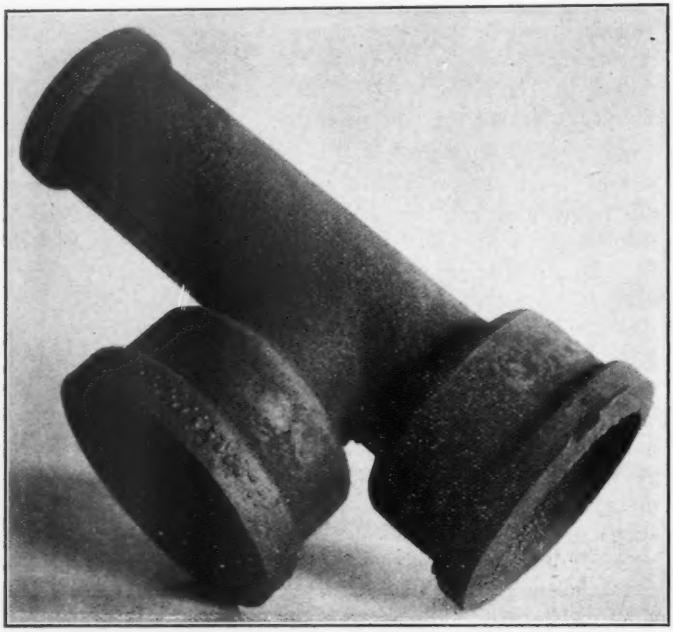

Figure 7

quenched in cold water, it has all the cutting power of a good high-carbon steel. This result is invariably obtained whether the iron be high or low in silicon, phosphorus, sulphur or manganese. There is no evidence of what we generally speak of as "chill"—no white crystals are shown; in fact, an iron that chills white first in the mold and is then quenched in water will

not harden in the manner described but will crumble when applied to the emery wheel.

The fact of the matter is simply that chilling molten iron swiftly to the point of setting, and then allowing it to cool gradually, produces a metal that is entirely new to the art. It has all the chemical characteristics of cast iron, with the exception of combined carbon, and it also possesses some of the properties of high-carbon steel. We have been taught that steel will not take a temper when it contains a very appreciable amount of free carbon, yet this piece of cast iron, that has .44 per cent. combined, and over two per cent. free carbon, has been tempered repeatedly and will do better service in a lathe than a very good non-alloy steel. Once this peculiar property is imparted to the casting, it is impossible to eliminate it except by remelting. A bar of iron so treated can be held in a flame until the metal drips from the end, and yet quenching will restore it to its original hardness. The analysis of the piece of treated iron before us is as follows:

Si.	2.28
Phos.	1.21
Sul.	.108
Mn.	.41
T. C.	2.65
C. C.	.44

An analysis of another piece shows:

Si.	2.24
Phos.	1.12
Sul.	1.01
Mn.	.38
T. C.	3.02
C. C.	1.54

It will be noticed that the carbon for the first piece is low—much lower than we like to have it for our general work. But

the remarkable feature about this particular phase of the process is that such a close-grained, tough and strong iron should be produced with an analysis such as given above. The analysis of this iron taken after it is removed from the mold, and without

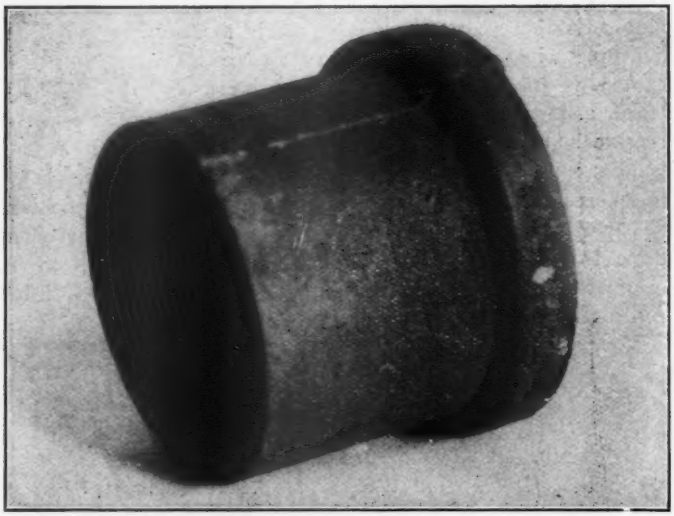

Figure 8

quenching, is the same as above, except that the combined carbon is not over .28.

The character of the iron before being quenched, is very fine, close-grained and yet it is easily machined. In all this work there are no blowholes, and any dirt that enters into the piece must come from the ladle.

In some of our earlier writings the effect of the carbon in cast iron was exhaustively treated; in order to make clear the chemical changes that occur in this process, it may be well to repeat some of the conclusions:

All the carbon in molten iron is in solution, and exists in the combined form. Now, if molten iron be *instantly* cooled to 1000 degrees F. all the carbon will be held in the combined form—

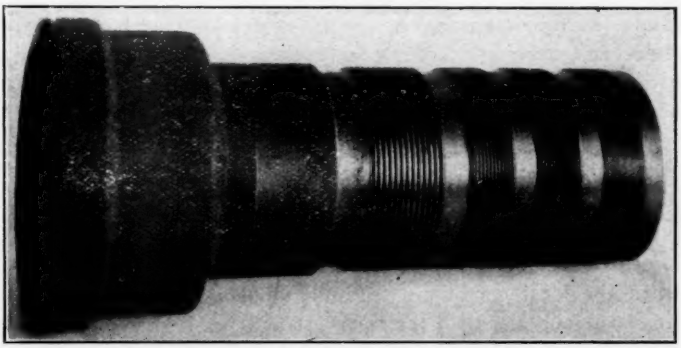

Figure 9

there will be no free carbon. If, however, it be instantly cooled to the point at which the iron sets, and then allowed to cool normally, the carbon will be in the combined form at the time of setting, but will change to the free form as the cooling progresses. This formation of free carbon is very rapid; the major portion present in the casting is formed within a few seconds after it is taken from the mold. The analyses below give a very

fair idea of this action, the pieces in question being 6 x 1¼ x ½":

	C. C.	T. C.
Cast in sand and cooled normally	.27	3.20
Taken from permanent mold at bright yellow and quenched	1.50	3.02
Taken from permanent mold at bright red and quenched	.49	3.10

It will be seen from this that two-thirds of the combined carbon has been changed in the few seconds required to cool from a bright yellow to the bright red. The free carbon in all these castings is not in the form of graphitic carbon, as we usually see it in ordinary cast iron, but partakes more of the character of annealing carbon. It is probably this annealing carbon that gives permanent mold castings their unusual strength and toughness.

The difficulties that confront an investigator who attempts to look into the manufacture of castings are so great, owing to the peculiar conditions that surround the art, that much of the information that has heretofore been given is of value only when the local conditions are fully known. Our present-day technical journals, with their earnest and persistent work, have gone far towards making the foundryman's art a scientific process; but, after all, the sum total of all these efforts has been to seek a remedy for the difficulties encountered, in a process that in itself must of necessity often give unsatisfactory results. Sand as a medium for making general castings will always hold its own. We have discovered nothing that is so cheap and so efficient, considering the vast range of work it is required to do. Its deficiencies are well known; but so far, all efforts to overcome these deficiencies have been solely in the direction of shedding light upon the *characteristics of the iron used.* We read a great deal about the evils of sulphur and of phosphorus, and we find that these evils are not exaggerated when it comes to making

castings in sand. But to my mind, the reason why phosphorus and sulphur are the bane of the foundryman's existence *is not because of the mere fact that sulphur and phosphorus are present in the casting, but because in slow cooling in sand molds, sulphur and phosphorus segregate.* Therefore, the great evil in cast-iron work is *not so much the presence of impurities, but the fact that segregation allows these impurities to mass themselves and thus destroy the homogeneity of the iron.*

Our experiments have shown that an iron containing 1½ per cent. phosphorus when cast in an iron mold is as strong as iron containing .4 per cent. when cast in the same mold. We can find no perceptible difference in the tensile strength under these circumstances. The same is true with sulphur at .1 and sulphur at .03, and it would seem, therefore, that the mere fact of the presence of sulphur and phosphorus in these irons is not deleterious when segregation is prevented.

It is not within the province of the sand mold to prevent segregation, and the remedy can not be looked for from that point; nor is it possible to prevent a certain amount of segregation in a permanent mold when the casting is so thick in section as to make the cooling comparatively slow. Fortunately, most of the duplicate work in this country to which the permanent mold is applicable is comparatively small section—very little of it is more than 1″ or 1½″ in the thickest part, and when a casting is not thicker than the figures given above, and is made in a mold properly designed, there will be absolutely no segregation.

The formation and segregation of graphitic carbon is familiar to all, and its weakening effect upon cast iron is very well known. The casting made as above described, and containing free carbon that is thoroughly distributed throughout every portion of the iron and is not allowed to collect in large flakes or bunches, will be as easily machined and will have greater tensile and crush-

ing strength than a casting made in a sand mold in the ordinary way.

The position the writer takes in this matter is that the evils of phosphorus and sulphur are due, not to the fact that these elements are present in the casting, but to the fact that the slow cooling allows them to collect in masses. If segregation were prevented a high-phosphorus or a comparatively high-sulphur casting would be just as strong as if these elements were low in percentage.

So far, we have discussed simply the use of the permanent mold as applied to the foundryman's art, with iron taken from the cupola. If, then, permanent molds can be used with success in the foundry, and a system of continuous pouring be inaugurated which in duplicate work would obviate the necessity of having molders, why is it necessary to melt pig iron in the cupola? What could be more ideal than a series of permanent molds supplied with molten iron practically direct from the blast furnace? The interposition of a reheating ladle such as is used by the steel makers of today, presents no unusual features; and this ladle makes possible the treatment of the molten iron. Modern practice has eliminated much of the uncertainty in blast furnace work, and it is not unusual to find these furnaces so equipped as to produce an iron that varies but few points from the quality desired by the foundryman. The molten iron we get from the blast furnace is much hotter than that obtained from the cupola, so that there is every reason to believe that the castings we would obtain would be of a better quality than when the pig is remelted in the cupola.

In our work we have conclusively demonstrated that it is immaterial whether an iron contains 1.75 or 3% silicon, so long as the molten mass is at the proper temperature, so that the high temperatures obtained from the blast furnace would go far toward offsetting the variations in the impurities. Given, there-

fore, a furnace properly equipped and properly handled, with the interposition of a reheating ladle, there is no reason why a very high class of work should not be obtained with the use of permanent molds. How far this thought can be carried out lies with the blast-furnace owner.

American Foundrymen's Association

MACHINE MOLDING vs. HAND MOLDING.

BY GEO. MUNTZ, WEST NEW BRIGHTON, N. Y.

It is surprising that in our century of improvements and automaticity, the foundrymen call mostly anything a molding machine, and that machines performing only a fraction of the Molder's work are known under that name. To the simple mind of a novice, the definition of a molding machine would be—a machine making just as good a mold as a molder does.

Up to now, we have passed from the plain squeezer performing only the ramming of the sand, to the most complicated automatic machines, which take a flask from a laborer's hand and return a mold. The molding machine then really exists, it has taken the place of the molder in certain cases, but not in all cases because it lacks adaptability. If we take a bench molder, able to handle a range of flasks from 10x12 to 16x20, he will be able to mold anything that can be put in those flasks, no matter how flat or deep the castings may be. That is what we call the adaptability of the molder.

The present automatic molding machines do the work, but only such work as they have been designed for. The field seems then to be a small one, as for each class of work a special class of machine is required.

I believe that an adaptable machine, just as adaptable, as the molder is, can be built, provided the proper principles are observed.

To make a mold, a machine has to be given, all that is given to the molder; i. e., a pattern, a flask, and sand, and then it

must be provided with such mechanical contrivances which will enable it to ram the sand, turn the mold over and draw the pattern. That is all that the molder does while molding. The patching up of the mold seems to be the only part requiring great skill from the molder, and this could be done away with, if the patterns were perfect, and if the molder were drawing them perfectly vertical when taking them out of the sand. It is there that the molding machine shows its superiority over the man, because if the molding machine is built to draw the pattern vertically, it will do so and do it all the time.

The main drawback to a universal molding machine is the lack of a universal ramming device. As far as the ramming is concerned the molder is universal. He knows that if he molds stove plate castings, he will have to ram the sand a certain way—if he molds hollow ware he will have to ram the sand another way. In some molds the sand has to be rammed differently during the progress of molding, and this, the molder can do, because he is the adaptable molding machine par excellence.

The ramming question has then been tackled in different ways. The first method was the result of a simple observation. The rammer of the molder, when it comes down on the sand, squeezes it upon a certain area, and it had been thought, that if the rammer were increased so as to cover the entire flask, and sufficient pressure applied, the ramming could be done just as well. It was the origin of the squeezers.

Practice shows that the piston or squeezer plate does not act like the rammer does, and this on account of the physical condition of the sand. If sand were absolutely dry and free of clay, in one word unfit for molding, it would pack perfectly even, but foundry sand needs a binder and needs moisture, and therefore becomes the poorest thing in the world to be compressed evenly over uneven surfaces.

But practice shows also that while the ramming is uneven in the immediate neighborhood of the pattern, it becomes very uniform above a certain distance of the pattern.

This observation brought Ph. Bonvillain and E. Ronceray to build their disappearing pattern molding machine. This machine is a squeezer, but the sand which is packed evenly over the pattern, is in turn used as a piston to compress the lower layers

of sand. This is done by building between the pattern and the piston supporting it, a prismoid following exactly the outline of the parting line of the pattern, and having about one third of the pattern height. The whole slides through a stripping plate and when only the portion of the pattern which is wanted appears above the stripping plate the ramming stops, while the pattern still goes down, drawing itself through the stripping plate. This method has been successfully applied and I have seen 6 three inch projectile shells, about 12″ long molded in a 14″ round flask, leaving ¾″ sand walls, and the sand was perfectly packed. The only apparent drawback is the cost of the pattern plates and the enormous size machine required for a comparatively small flask.

Another French inventor recently had the idea of using compressed air, but without any piston. The flasks he uses are special and when filled with sand, are covered with a chamber the bottom of which is a rubber sheet. Compressed air is then admitted, and the rubber sheet acts as a piston and squeezes the sand evenly. Of course, the surface of sand left by the rubber sheet, is far from being a plane, and requires some striking off for each mold. At some time in the near future I expect to show the possibilities of this machine.

The molder has been observed in one of his ways when the squeezers were designed, but he has other ways of ramming. For instance in ornamental molding and in deep work, he often takes the sand in his hand in the shape of a soft ball, and throws it on the pattern. If this operation is repeated a certain number of times, the whole mold can be rammed in this fashion. This observation was the origin of the so called "Gravity Machines." It is evident that in such machines, the mold has to be guided by hand, or else the sand would be packed harder in some places than in others, and this introduces the personal equation of the man which is the greatest antagonist to automaticity.

There is another method, used more by the core maker than by the molder, and which consists in taking a corebox full of sand and pounding it on a table until the required degree of hardness of the sand is attained. This method has been very successfully applied in the "Jarring Machines," and molds are

made by this method that are perfect in every respect. The only inconvenience I ever experienced with such machines was that the sand would not pack hard enough on top of the mold, but this was easily remedied by casting heavy plates of the size of the flasks used and placing them on top of the molds while ramming.

Of course the jarring machine requires heavier foundations than any of the other molding machines, but such foundations are made every day for steam hammers, and I fail to see why the same sacrifices should not be made in the foundry.

It always seemed to me that molding machines were considered like step-sisters to the other machine tools, and that every effort was made to keep them from attaining the same degree of perfection as the modern lathes and milling machines. To do away with skilled labor, very intricate machine tools have been built, and if you are standing in front of one of these productions of human genius you will notice that every operation of the machine has been designed to replace some motion of a skilled hand. It is in this manner that a screw machine is fed with a roll of wire, and turns out thousands of perfect screws under the mere supervision of a boy or an unskilled laborer.

When the molding machine salesman interviews the purchasing agent of a foundry, he is always received by the latter with a desire for a very simple machine, which will do in the hands of an unskilled man the work of a skillful molder. Molding machine manufacturers have then, thus far, only been able to produce fractions of the machines which would do, in the foundry, what the automatic lathe and the copying milling machine do in the machine shop. A molding machine to be as universal in the foundry as the automatic lathe is universal in the machine shop, has to be just as complicated and what is more, has to be built so as to meet the exacting condition created by the presence of dust and soot, without which a foundry would not be a foundry.

In going over the various ways of ramming the sand on a molding machine I stated that the "jarring method" was the most suited for the purpose, and the future will tell whether this is correct or not.

The rolling over of the molds, the drawing of the patterns,

and the motive power of the machine are the only problems left to be considered. These have been worked out in innumerable ways, for they call only for the most usual mechanical contrivances.

I believe that to be successful, a universal molding machine should produce in one operation the cope and drag of the mold, for in doing so an appreciable amount of handling is saved and a considerable number of mistakes avoided. This, of course, is not a rule because when it comes, for instance, to molds of 6x9 feet, the machines would be so monstrous in size that they would be impractical.

There is another case where it would be better to produce only one part of the mold at a time, namely when a reversible pattern plate is used; the cope and drag of the mold are then identical, and only one pattern plate is required for making a complete mold.

To draw the pattern mechanically, we had better first observe how the molder does it. When the mold is rammed up, and the pattern is not a split pattern, the cope has to be removed very carefully so as to avoid breakage of the sand. In removing the cope, the molder has to do a certain amount of guess work, as he never knows the extent of the damage until the cope has been rolled over and placed along side of the drag.

To remove the pattern from the drag it is very easy because the molder sees what he is doing and if he raises the pattern a little too much on one side the sand breaks and tells him that he has to incline a little more on the other side. It is then no wonder that the drag part of the mold has always been the mold's pet part of the molder, and that he is never so pleased as when he gets a split pattern where he can remove the two halves from the cope and drag in the same fashion. Moreover when the pattern is drawn in this manner the sand might break, but there are seventy-five chances out of a hundred that it will approximately take its place after the pattern is removed and then will only have to be secured in the right place.

This is the method we will have to follow in drawing the pattern by machinery, because every pattern can then be considered as a split pattern. It means of course an unnecessary

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rolling over of the cope, but this is such a trifling inconvenience that it is not worth while to stop at it.

As far as the motive power is concerned there are two kinds of power, which the foundryman has always handy, namely the hand power and the power he derives from the motor driving his blower. The first has been catered to a great deal and is, I think, quite primitive. It always reminds me of the days of the foot driven lathe when I see one of the hand squeezers where the pressure could so easily be applied by power, and where a man has to hang with all his might to a lever while making a hundred consecutive molds and then has to pour off and shake out. Compressed air and water under pressure are now used, but they mean greater initial expense and are some of the reasons why foundrymen do not use molding machines to a greater extent. Then why not cater to that other power which the foundryman has always handy. It takes very little to drive a molding machine, then why not make it belt driven, or why not make it self contained and have its own motor. While the efficiency of compressed air is disastrous, the hydraulic power is most efficient, and I was once a convert to it, but I soon found out that water does not agree very well with sand and metal patterns. Leaks are frequent wherever piping is to be used, and while they mean only waste of power with compressed air, they mean waste and trouble with hydraulic machinery.

No wonder then that I prefer the belt and pulley drive or better an electric motor in a dust proof case, directly geared to the machine.

In conclusion the molding machine of the future will be just as automatic as the improved machine tools of the machine shop. It will be belt driven or be self contained and have its own electric motor. It will unquestionably have a universal ramming device based on the jarring method of ramming, an automatic clamping device, which will allow the molds to be rolled over without any fear of the flasks coming apart from the pattern plates, and an automatic and adjustable pattern drawing arrangement. And here is where we hear the foundrymen say that it will take mechanics to run such machines. It will not

any more than it takes mechanics to run automatic screw machines.

In every machine shop there is a tool maker who has the supervision of all the machines and equips them with the tools without which they would not be automatic. In the modern foundry there will also be a kind of a tool maker, but this man will have to be even more universal than his brother of the machine shop, for besides being a machinist he will have to be a molder. He will make the pattern plates and look to the fulfillment of good working conditions of the machines.

Foundrymen now have everything necessary for a solution of the problem. They know that molding machines will never take the place of the good all around molder, but will be a great help to him in the tedious task of duplicate work. They know also that the foundry in any big concern is always the largest dividend payer although the methods employed to come to this result are the same as our grandfathers used on a smaller scale.

It is then time to modernize and come, in the foundry, to the same pitch of improvement as we have come to in the machine shops.

We have good examples, we only need to follow them.

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American Foundrymen's Association

THE USE OF STEEL SCRAP IN THE CUPOLA

BY C. R. MCGAHEY, RICHMOND, VA.

The Foundryman of today is confronted with the problem of what kind of cast iron he shall try to make. Whether to go into irons that show greater elasticity and strength, or to stick to softness regardless of what the work is intended for.

In working on this problem myself, I took for my standard for comparison a test bar longer than the ordinary, as this did not run the breaking strengths too high, and also gave deflections more readily observable than with the ordinary 1¼" round bar broken on supports 12" apart.

My tests ran from 750 pounds up to 2,400, with a 1" by 1" by 24" bar, separately cast—not as a coupon. The deflections approximated from 0.10" up to 0.55". This range obtained with all kinds of iron in the ordinary run of shop work is not at all satisfactory, and it would seem that some point ought to be selected to which foundrymen should work in order to get the most satisfactory product in regular jobbing castings—not special work.

To best resist repeated strains, shock, and heavy work, it is necessary to run the elastic limit up as high as possible and yet hold a good deflection. Since the breaking strength and elastic limit in cast iron are not far apart, we would naturally try to get our transverse test quite high, and for the bar in question aim at 2,000 lbs. and perhaps even higher, the deflection running up to 0.50".

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It is further necessary to reduce the shrinkage to a minimum, so that the interior strains may be obviated as much as possible. This is particularly the case where pulleys, fly wheels, and the like are made. A careful study of the chemistry of iron will assist in this, and the addition of steel to the mixture, thus reducing the total carbon, gives us the best solution. In this way it is possible to run up the strength of the bar 70% and also greatly increase the deflection.

The terms Semi-steel and Ferro-carbon, while used with good intentions are entirely misleading, as we do not convert the iron charged to steel or anything like steel, but simply dissolve the steel scrap added in the iron mixture, making it of higher strength. It is cast iron just the same.

Now in using steel scrap, much depends upon the coke for the fuel. I have found that with mixtures of the same composition and make up, with one coke I would get a high strength, and with another quite the reverse. The melting conditions were exactly the same, and the peculiar results are doubtless due to the composition, structure, and behavior of the coke in the cupola, causing the iron to melt more or less fast and remain in contact with the fuel to a greater or less extent. Thus a coke with a low ash—or in other words high fixed carbon—gave a very hot looking iron, but with a much lower transverse strength than another coke higher in ash, but with the same sulphur (0.54). The addition of more steel scrap to the better coke gave the strength more nearly equal to the other metal, showing evidently a greater absorption of carbon from the fuel with the better coke and hotter metal.

It is therefore necessary to understand the fuel and melting conditions well in order to obtain desired results. It is further necessary to run quite hot, and when much sulphur is present, to carry high manganese as this tends to flux off the sulphur as a manganese sulphide. A very interesting observation was made when an accident stopped operations for a short time. The test bars made from the metal right after starting up again ran very much better than the average of the run. It seems as if the stoppage gave the steel time to get very highly heated up, and hence it melted more readily, thus producing lower carbon cast iron, with consequent higher strength.

To get the materials of the charge to mix well is very desirable. I have had the best results when allowing the bed to burn for two hours—having it heavy enough to allow this—then to use very mild blast (from five to six ounces only). This always gave me higher strengths than when I used an eight ounce blast or higher. If time is given for the steel to melt and mix with the cast iron, the total carbon will be lower than if the cast iron of the mixture flows by the steel fast and has no chance to unite. For this reason also it is better to place the chunky pieces of steel low down, and the smaller pieces above. This allows the cast iron to wash it as it goes down, and unite with the steel, making a low carbon cast iron with consequent strength.

The reduction of the total carbon by steel additions makes the resulting castings very much denser. If now the sulphur is controlled by hot melting and high enough manganese, and the phosphorus kept down (my best work has been with phosphorus about 0.230) very serviceable castings are made.

Another point that will be seen in this steel scrap addition melting is the rather great irregularity of the silicon reduction in hot runs, and in the sulphur content. The latter will vary very much indeed. Silicon, on the other hand, usually runs about 0.25 loss in normal heats, but is much greater if the temperature gets up fast. The deflection is better when the sulphur is down.

The following are some results that may be of interest: Metal which would have about ¾" chill and be entirely gray when cast in sand, in the 1" square section, had Silicon 0.82, Sulphur 0.097, Phosphorus 0.23, and Manganese 0.54. This metal in a bar 1"x 1"x 24" broke at 1,800 lbs. with a deflection of 0.38". The percentage of steel carried was 7. The coke used contained Sulphur 0.54, Phosphorus 0.63, Fixed Carbon 92.53 per cent.

Another test gave Si. 0.88, S. 0.081, P. 0.24, Mn. 0.67. The test bar broke at 2,200 lbs. with 0.40" deflection, and the charge contained 20% steel.

A third test gave Si. 0.58, S. 0.097, P. 0.25, Mn. 0.44, and the bar broke at 2,250 lbs. with 0.48" deflection, and had 23% steel scrap (structural shapes).

Another good mixture gave Si. 0.79, S. 0.081, P. 0.239, and Mn. 0.64. This carried 21½% steel scrap.

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I find that to get the strongest bars, I have to keep pretty close to these analyses, and have made my strongest bar at 2,350 lbs., with 0.55″ deflection. The iron had a fine grain, was low in graphite, but machined nicely.

When ferromanganese was used, about 1% was found to be best. The above resulting compositions (the silicons of the mixtures being calculated to bring them about) are intended for castings ranging from 1″ to 2½″ in section. Should heavier work be required it is better to run the silicon in the pig up to 2.75, and the manganese up to 2.00, and to use 33⅓% steel scrap.

I hope that these few hints may be of value to the foundryman looking for strong and yet elastic irons.

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STANDARDIZING FOUNDRY FACINGS

BY H. F. FROHMAN, CINCINNATI, O.

Standardizing every article of manufacture and every commodity seems to be the order of the day. This not only applies to the Iron and Steel Industry so far as its finished products are concerned, but to every article that enters into the manufacture of these products. The Foundry is also sharing this tendency of the times, and to the writer has been assigned the problem of suggesting standards for the more common varieties of foundry facings in use today.

Most every foundry, whether producing large or small work must use Sea Coal or Bituminous Facing. This is a ground coal mixed with the sand to prevent it from fusing together and at the same time peel the casting.

This Sea Coal Facing must be high in volatile matter, low in ash and sulphur. It must be known as a gas coal, and the most suitable coal for this purpose should show approximately the following analysis:

Moisture	1.40
Volatile Matter	37.66
Fixed Carbon	54.44
Ash	5.86
Sulphur	0.64

Not only should this Coal show high in volatile matter and fixed Carbon, but very low in Ash and Sulphur, but also this Coal must be ground to practically the same consistency as the moulding sand used for the castings.

In other words, for heavy work a rather coarse sand is used and the Sea Coal used for this purpose should all pass through a No. 14 mesh. For general or medium sized work, the sand of course being finer, it would require a finer ground Sea Coal Facing, and this all to go through a No. 18 mesh.

For small castings such as stove plate and radiator work, naturally requiring a very fine and rather close sand, it requires a Sea Coal Facing in accordance therewith, and all of this Sea Coal Facing should pass through a No. 32 mesh.

There is also a Sea Coal Facing which is termed "Bolted," which is used for very fine Ornamental Castings requiring extremely sharp points. As this requires also a finely bolted sand in order to make a clean surface and not in any way disturb the face of the Mold, so it is necessary to have a bolted Sea Coal Facing, which is practically of the same fineness as the moulding sand.

Sea Coal Facing is used to mix with the sand to peel the castings, proportions running from 1 part of Sea Coal Facing to 10 to 30 of Sand, depending upon the size of the castings.

For what specific purpose Sea Coal Facing is mixed with the sand, has not been fully decided upon, nor have our practical foundrymen, or Chemists given us any sufficiently satisfactory reasons yet why Sea Coal Facing mixed with the sand will peel the casting.

In the writer's opinion, Sea Coal Facing is mixed with the sand not only to prevent the sand from fusing, but also to vent the Mould.

There has also been suggested that a good grade of Sea Coal Facing with high percentage of volatile matter, when the hot iron comes in contact with the Mold, forms a gas or cushion, so that the molten iron does not come in thorough contact with the Molding Sand.

As stated, this may be merely a theory, as it has not been absolutely determined what real action takes place when the molten metal comes in contact with the Mold, and makes this separation.

In our experiments, we have molded brake shoes, using the same sands under the same conditions, mixing the sand 20 to 1 with the following: (1) Sea Coal, (2) Ceylon Plumbago,

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(3) Charcoal, (4) Anthracite (5) Sawdust. All of these different materials ground to the same fineness as Sea Coal Facing. The only good castings produced where the iron did not burn into the sand, was the mold made with sea coal facing. The Ceylon Plumbago experiment indicates that it is not the separation of the sand particles by a medium preventing fusion. Sawdust contains more volatile matter than Sea Coal, but would not peel the casting. This disproves the cushion theory. The formation and following deposition of certain hydro carbons, yielding carbon which peel the casting, may furnish a more plausible explanation.

This theory does not question or exclude the beneficial effect of Sea Coal as a venting medium, nor its influence in preventing a fusion of the sand by the separation of sand particles.

PLUMBAGO.

In making castings, especially medium and large size, something is required to face the mold; that is by facing the mold, I mean covering the pores of the sand, so that the mold will practically have a smooth surface.

The very best article for this purpose is Plumbago or Graphite with a high percentage of Graphitic Carbon. The crystalline form from Ceylon giving the best results. This Plumbago must contain a certain percentage of Graphitic Carbon so that when the molten iron is poured into the mold, it will assist the iron to find its proper resting place, and be of such a refactory nature that the iron cannot cut into the mold itself.

A good Plumbago or Blacking must not only have the proper chemical analysis, be of such a refractory nature to withstand the hot iron from cutting into the mold, but also be of such a nature that it will not retard the flow of the molten metal, but on the contrary, assist it to glide along.

From experience in many years past it has been found that Plumbago or Graphite of a high Graphitic Carbon (Ceylon grade being the best), is the most suitable for this purpose, not only in dry sand, but in green sand work, and also for blacking cores. There is no doubt that a high grade of Plumbago makes the most suitable facing or blacking for producing a bright, clean casting.

Ceylon Graphite (high grade for facing purposes), should analyze about as follows:

Moisture	1.20
Oxide of Iron	5.90
Aluminum	3.06
Lime	0.90
Silica	16.14
Graphitic Carbon	72.80

The bulk of Ceylon Graphite imported for foundry facings runs between 50% and 60% Graphitic Carbon. These are straight Ceylon Graphites, not touched by the Facing Man. In the face of this fact an amusing instance may be mentioned here. We had made a shipment of straight Ceylon Graphite showing 62% Graphitic Carbon to an eastern firm; their chemist was of the opinion that all Ceylon Graphites analyzed 100% Graphitic Carbon. With great care he figured out to the third decimal how much of an inferior article we had added to the Ceylon Plumbago, and we "got it."

Relative to Coke Blacking used on certain classes of work, this should analyze:

Fixed Carbon	88.0
Ash	9.0
Sulphur	0.8

Anthracite Blacking when used as a Pipe Blacking or Mineral Facing should show:

Moisture	7.0
Fixed Carbon	84.0
Ash	9.0
Sulphur	0.5

A good grade of Charcoal Facing which is generally used by the foundries, not only for parting purposes, but also for foundry facing and as a core wash, should analyze:

Volatile Matter	10.0
Fixed Carbon	85.8
Ash	3.7

Ash varying according to the kind of wood and time of cutting.

In judging a foundry facing such as Graphite, Coke, Anthracite, Charcoal, the carbon percentage should conform as near as possible to the above.

American Foundrymen's Association

A COMPREHENSIVE FOUNDRY PRODUCTION TALLY

BY C. E. KNOEPPEL, ERIE, PA.

There can be no question, after one appreciates fully all that this Convention means to the foundry industry, that the one great demand of our times, which perhaps overshadows every other, is a greater productivity—the factor upon which depends the securing of a higher degree of efficiency and increased earnings. Productivity—the relative amount produced—is not only applicable to the men on the floor or in the core room, but to the methods in use, the clerical work, the moulding machines, the cupolas, cleaning room, the yard and laboring force, the selling branch of the business, the executive himself and if this factor is increased only a trifle at each point, the ultimate results can not be anything else but beneficial, in fact it is the little things which are sometimes overlooked, because they are little, that amount to something substantial in the aggregate.

It has been well said that concentration of endeavor is one of the roads to success but the necessary requirement is a knowledge just where to concentrate. What is being accomplished is perhaps apparent and evident but it is in a consideration of what can be done or what is not being done where the latent possibilities for betterment will be discovered. As nothing is large or small except through comparison, proper information regarding what is being done should be available for study in order to have a basis for judging whether results are satisfactory or otherwise.

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This study should not be an occasional, half-hearted, incomplete sort of an affair but a critical, systematic analysis all along the line. By analysis is meant the thought or reasoning applied to the comparison of compiled information, enabling the executive to pick the bad from the good and arrive at some conclusion from which he can act intelligently, in fact this analysis of results is just as important to the success of the foundry as a business, as analysis of iron is to the melting operations, as a single department of the business.

A foundryman wants to know where he has made or lost, how much and why; he wants to know how low he can consistently bid on certain classes of work; what he can do at varying productions; where his money is going, etc. This knowledge he must have if he is to strengthen the links of his business—not a link here and there but *all* links. Such information is the product of this analytical process which picks to pieces all cost figures, production data, facts concerning returns, replacements, etc., all of which are not only guides but form the basis for determining in advance what he can do in the future at varying productions.

It should need little argument to convince the foundryman that from the standpoint of good business; of possible financial gain, a full and complete knowledge of his pertinent information, properly arranged and classified for future use, is not only essential but necessary when one considers the fact that efficiency is the elimination of inefficiency—once it is found. At any rate, information should have a chance of working for the executive—not a burial which has no resurrection.

The purpose of this paper is to outline a method for collecting the principal production and cost figures with which the usual foundry is concerned, the method in question having been designed to furnish as much information from the original writing as possible and as it has passed from the experimental stage to a point where it not only gives results but covers quite a little ground, it is hoped that its description will interest those connected with the foundry industry.

We will therefore assume, in describing the method, that in a foundry the costing arrangement provides an account number for the different kinds of work, as for instance No. 150 for moulding labor, No. 151 for core labor, No. 152 for cupola labor, No. 153

cleaning room labor, No. 158 replacing bad castings made in the foundry, No. 171 repairs to plant equipment, etc.; that all production and production costs are classified according to customers' work, each customer having a separate number for identification and recording purposes and that the monthly costs are carried through the general books.

As orders are received from customers, the stenographer makes two copies, one of which remains on file in the office, the duplicate going to the office of the shipping clerk, where the foundry foreman notes the orders received and their progress as occasion demands. From the office record, a clerk makes out a moulding and core order (moulding order shown at figure No. 1 with reverse side at No. 2) which are sent to the pattern storage. The patterns and core boxes are brought out, checked and sent into the foundry, the core boxes going to the core room while the patterns are placed in racks from which the foreman or his assistant designates on the cards, the men who are to make the work called for, from which point delivery is made to the moulder, the moulders depositing their moulding orders in little tin boxes provided for the purpose, on or near their floors.

Reference to figure No. 1 will show that the order in question calls for 50 castings from pattern x621. As the work is tallied up each day, the number made is posted to the reverse side of the order and the balance to be made inserted, the illustration showing that it took six days to run out the 50 pieces. As castings which have been made are found defective, the number bad is posted as shown under "shortage record" and when the total number called for by the moulding order have been made, the number bad is totaled and inserted in the "required" column as shown at figure No. 2. In this way the tally clerk knows exactly what is regular work and what is replace work, the illustration showing that 63 castings were made to get 50 good ones. Another advantage is that the balance to be made is known at all times, a point worthy of consideration when another moulder is given the job to finish. In addition to this, the pattern is not taken to the pattern storage until the 50 good castings have been made, which does away with the work of sending the pattern to the pattern storage after the ten bad castings were replaced, only to

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SHORTAGE RECORD.

DATE	BAD	DATE	BAD	DATE	BAD
3/12	1				
3/13	2				
3/14	2				
3/15	3				
3/16	2				
	10				
3/18	3				

FORM 27--9-08--2M

Walker Foundry Co.

MOLDING ORDER.

Date 3-10-09 Symbol 18

Ord. No. 6460 Req'd 50

Patt. X621

Wanted 3-25-09

Molder 143

Remarks

(1)

Figure 1

DATE	REQ'D	PS. MOLDS MADE	BAL	DATE	REQ'D	PS. MOLDS MADE	BAL	DATE	REQ'D	PS. MOLDS MADE	BAL
3/10	50			3/18	3		3				
3/12		10	40	3/19		3	-				
3/13		5	35								
3/14		10	25								
3/15		6	19								
3/16		12	7				(2)				
3/17		7	0								
3/17	10		10								
3/18		10	0								

Figure 2

XUM

WALKER FOUNDRY COMPANY

FOUNDRY TALLY

Symbol 15 Date 3-20-09
Man No. 201
Order No. 6420-150
Pattern No. 315
Pieces Molds } Made 10
CAST Not Cast Est. Time Allowed

COST DETAILS	DAY			PIECE			
HOURS	RATE	AMOUNT		PCS.	Credited	RATE	AMOUNT
2							
2.9	.30	87					

GOOD: Pcs. 10 | Weight 350
Pcs. Bad:
Working with
Dept. Side
Shipped
Via
Billed

Symbol 10 Date 3-20-09
Man No. 201
Order No. 6518-150
Pattern No. Z 60
Pieces Molds } Made 5
CAST Not Cast Est. Time Allowed

COST DETAILS	DAY			PIECE			
HOURS	RATE	AMOUNT		PCS.	Credited	RATE	AMOUNT
+				4		12	48
1.3					1		12

GOOD: Pcs. 4 | Weight 400
Pcs. Bad: 1
Working with
Dept. Side
Shipped
Via
Billed
(3)

Symbol 20 Date 3-20-09
Man No. 201
Order No. 6610-150
Pattern No. A 1340
Pieces Molds } Made 15
CAST Not Cast Est. Time Allowed

COST DETAILS	DAY			PIECE			
HOURS	RATE	AMOUNT		PCS.	Credited	RATE	AMOUNT
2							
2.9		87					

GOOD: Pcs. 10 | Weight 625
Pcs. Bad: 5
Working with
Dept. Side
Shipped
Via
Billed

Symbol 3-158 Date 3-20-09
Man No. 201
Order No. 6530-150
Pattern No. L 32 A
Pieces Molds } Made 2
CAST Not Cast Est. Time Allowed

COST DETAILS	DAY			PIECE			
HOURS	RATE	AMOUNT		PCS.	Credited	RATE	AMOUNT
2							
2.9		87					

GOOD: Pcs. 2 | Weight 250
Pcs. Bad:
Working with
Dept. Side
Shipped
Via
Billed

Figure 3

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find, we will say, that three of the ten replaced were found defective and must be made over again, necessitating the bringing back of the pattern.

We will assume that the work in the foundry is all up for the day; the blast on and the men in readiness for their iron with which to pour off their work. The tally clerk takes a pad of tally sheets, illustrated in figure No. 3, which consists of perforated slips, the sheets being in original (paper) and duplicate (manila board) for moulders only and in original only for ail other employees. On these slips he proceeds to write up the work of each employee for the day, securing his information covering work done by moulders and core-makers from the moulding and core orders, posting this information to these orders as well as to the tally slips, and as he has with him a record of the bad work made the day before, he also posts to the moulding and core orders, the work rejected. For all employees other than moulders and coremakers, the nature of the work governs the entry to the original or paper slips.

In tallying up the work of the moulders and coremakers, the clerk enters on the slips, the symbol number; date; man, order and pattern numbers; the number of pieces or moulds made; the department and the actual time spent on the work. For all other employees, the clerk fills in the date, man number, account or shop order number in space "order number" and the hours spent on the work.

The slips for moulders covering work put up during the day, is checked in the space provided for the purpose, as "cast" if the work is ready for pouring and as "not cast" if the work is not completed.

Should the foundry foreman allow a workman extra time, the amount of this time allowance is inserted in space provided on slips, which must carry the O. K. of the foreman. See figure 7.

When two or more men are working on one job, the slip covering the work of each man shows the number of the man or men he is working with. See figure 7.

Labor replacing castings not passing inspection is handled as new work with the exception that the symbol number is followed by the account number designating replace work and

shown in figure No. 3 (bottom slip) as No. 158, the No. 150 following the order number meaning moulding labor.

When the tally is completed, the clerk sends all original or paper sheets to the office while the duplicate sheets covering production are forwarded to the shipping department. The shipping clerk has two files arranged as follows—

A—For "work coming through,"

B—For "castings on hand,"

which are indexed by symbol numbers and cross indexed in some cases by name of pattern, as for instance beds, cylinders, pulleys, etc., for customers whose work amounts to quite a little. The clerk takes the sheets just received, tears the slips apart and files them according to symbol number, by pattern number, by date in the file for "work coming through." Figure 3 illustrates a tally sheet covering the production for a man for the day. As received by the shipping clerk, immediately following the tally, the sheet does not show the entries covering the number and weight of the pieces good, the pieces bad or the cost postings. As separated and filed, the file for "work coming through" would show along with all the other work—

10 pieces made and cast from pattern 315 for symbol No. 15.
5 pieces made and cast from pattern Z60 for symbol No. 10.
15 pieces made and cast from pattern A1340 for symbol No. 20.
2 pieces made and cast from pattern L32A for symbol No. 3.

On the day following the making of the tally and after the castings have been cleaned and inspected, the inspector takes the file for "work coming through," weighs up the good castings and enters on the slips the number and weight under "good." After this is done the postings are made from the pile of scrap covering the pieces bad. All slips to which entries have been made from the inspection, are placed in the front of the file while those slips covering work which was either not cast or cast but not cleaned are put back in their proper place in the file from which they were taken. The file is then sent back to the shipping department and the tally clerk goes through the slips in the front of the file (the results of the inspection) and makes a list of all work found defective, to be used for entry to the moulding orders when the next tally is made, this same list being used by the foreman for purposes of analysis. The slips are then

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sent to the office, where entry as to the inspection results is made to the corresponding original or paper slips, the duplicates being marked with a letter "E" denoting entry and returned to the shipping clerk who distributes them in the file for "castings on hand." It might be well to state that the slips placed in the front of the file by the inspector, also include slips showing all the work made as bad, for the reason that such work ceases to be work coming through and while not castings on hand, should first be posted to the corresponding slips in the office and then placed in the file for "castings on hand" in order that the shipping clerk may know that the work was made and proved defective. When the slips covering the good castings replacing the bad come through, the slips for the bad work are taken up and destroyed.

When castings are ready for shipment, the corresponding slips are removed from the "castings on hand" file, marked with the date of shipment and the routing and as soon as the shipment is made, sent to the office where they are then used as the authority for rendering invoices to the customers. It often happens that the shipping clerk wants to make a shipment as soon as a casting is cleaned or a casting will be rushed from the foundry, cleaned as quickly as possible and shipped. In cases like this, the shipping clerk takes the duplicate tally slips from the "work coming through" file, enters the proper information and sends them direct to the billing clerk for invoicing.

Let us consider for a moment some of the special conditions this arrangement takes care of. Assume that a casting has been started but that it is not completed at casting time. The tally clerk would tally this work as shown at figure 5, showing that no pieces were made and that nothing was cast. The slip would be filed in the "work coming through" file, reference to which would show that the work was started but not completed. We will assume that on the day following, workman No. 121 spends four hours finishing up the job, which is cast the same night. The tally clerk would make out a slip and when filed it would fall in front of the slip for the 20th. On the day following when the casting is inspected and reported as good, this information would be posted to the slip for the 21st and sent to the office

PAY ROLL SLIP (4)

MAN NO. 201 DATE 3-20-09

NAME Smith

DEPT Side Floor

JOBS WORKED ON

6420-6518-6610-6630

COST DETAILS ITEMS	HOURS	AMOUNT
DAY WORK	8 7	2 61
PIECE WORK	1 3	60
OVERTIME		
ALLOWED _____ HOURS		
TOTAL FOR DAY	10 -	3 21

(5)

Symbol 10 Date 3-20-09 — Order NOT CAST — Rt. Time Allowed

Man No. 121

Order No. 6432-150

Pattern No. X10

Pieces Made

Molds Made

COST DETAILS	DAY		PIECE			
HOURS	RATE	AMOUNT	PCS.	Credited	RATE	AMOUNT
10		375				

GOOD: Pcs. | Weight — Pcs. Bad — Working with — Dept. Main

Shipped — Via — Billed

(6)

Symbol 6 Date 3-20-09 — CAST NOT CAST — Rt. Time Allowed

Man No. 160

Order No. 6321-150

Pattern No. 632

Pieces Made 1

Molds

COST DETAILS	DAY		PIECE			
HOURS	RATE	AMOUNT	PCS.	Credited	RATE	AMOUNT
10		250				

GOOD: Pcs. | Weight — Pcs. Bad — Working with — Dept. Main

Shipped — Via — Billed

(7)

Symbol 18 Date 3-20-09 — CAST NOT CAST — Rt. Time Allowed 2

Man No. 133

Order No. 6340-150

Pattern No. X1624

Pieces Made 1

Molds

COST DETAILS	DAY		PIECE			
HOURS	RATE	AMOUNT	PCS.	Credited	RATE	AMOUNT
10		50 250				

GOOD: Pcs. 1 | Weight 10,000 — Pcs. Bad — Working with 240 — Dept. Main

Shipped 3-23-09 — Via L. S - M. S. R. R. — Billed 3-24-09.

Figures 4, 5, 6, and 7

while the slip for the 20th which is no longer of any use, is destroyed by the shipping clerk. Here we have a complete history of the transaction for we have first a knowledge that the work was started but not completed; then completed and cast but not inspected and finally inspected, reported as good and ready for shipment. On the other hand should this casting have taken four days to make, there would be duplicates on hand in the file for "work coming through" for the 20th, 21st, 22d and 23d, the one for the 23d showing that the work was made and cast and when reported as good, the other three slips would be destroyed.

Let us consider a case where a large casting is made and cast the day it was started, as shown by figure 6, but that it remains in the sand during the following day. The slip would be filed with "work coimng through" and on the 21st would be taken with the others in order to post the results of the inspection. In going through the list, the inspector finds that no such casting was cleaned. He therefore puts it back in its proper place in the file and if any reference is made to it on the 22d the slip will show that the work was made and cast on the 20th, not cleaned and reported as good on the 21st and until the inspection is made in the afternoon, the work in question is still in an unfinished condition. This illustration also applies to cases where work is made and checked as cast but not poured because of a shortage of iron. A follow up from the tally slips will show whether the work was made but not cleaned or made and not cast.

Let us assume, as shown by figure 7, that workman No. 133, assisted by No. 240, made and cast pattern X1624 on the 20th for symbol 18, in ten hours, each being allowed two hours extra for making the piece in one day; that it remains in the sand during the 21st, is cleaned on the 22d and shipped on the 23d over the L. S. & M. S., and billed on the 24th. Any reference to the file on the 20th for this particular job, up to the time of the tally, would show that the work was not made as yet, although the foundry would report it as being in process if an investigation was made. After the tally has been made for the day, however, and the slips torn apart, the "work coming through" file would contain the slip for this job, showing that it was

made and cast. When the inspection is made on the 21st, the casting in question would not be found and the slip would be put back where it was taken from, any reference to it on the morning of the 22d still showing it as work coming through. After the inspection on the afternoon of the 22d, the weight would be entered, the slip sent to the office along with the others, the weight transferred to the original, returned to the shipping clerk who would file it in the "castings on hand" file where it would remain until shipment was made from which point the procedure is as preivously outlined.

In cases where castings which have been reported as good, slips for which are in the "castings on hand" file, are subsequently found defective before being shipped, the slips are removed, marked "scrapped" and sent to the office for charging to the scrap account, for the scrap value, while the castings would be either taken to the scrap pile or the cupola.

Let us now follow for a moment the proceedure in the office. The foundry clerk on the morning following the making out of the tally, takes the original or paper slips which have been sent to him and proceeds to enter the cost details. From his record of piece prices and day rates, he extends the earnings for the day as shown at figure No. 3, the top slip showing that workman No. 201 earned 87c. for the 2.9 hours charged against symbol No. 15. In explanation of the change in hours on the top slip, from 2 to 2.9 hours, it would be well to state that a conversion table is used when posting earnings to the moulders' slips, in order to convert actual moulding time into the full time for which the moulder is paid. For instance a moulder spends eight hours of his day on four jobs of two hours each, the other two hours being spent in cutting over the sand in the morning and pouring off and shaking out the work at night. As the cost of this two hours time is as much a part of the cost of the four jobs as the direct moulding cost, each job must necessarily absorb a certain amount of this extra time and inasmuch as it would be difficult for the moulder to state how much of this time is applicable to each job, an equal amount is added to each, making the moulding time 2.5 hours instead of two hours. The conversion table is figured at various combinations of direct moulding time from six to nine hours, for

various job times from one to ten hours and their fractions in tenths of hours.

When piece workers lose work for which the foreman decides to pay them, the foundry clerk is notified. For instance the second slip in figure 3 shows that of the five made, four were good and entered in the "piece" column but as the foreman decided to pay the moulder for the bad casting, the foundry clerk enters it under "credited" both of which are extended at the piece prices. Time allowances are shown at figure 7.

After all the slips have been rated, extended and checked against the "in" and "out" clock tickets in order to make the times agree, the foundry clerk takes a pad of payroll slips, illustrated in figure 4, and enters the man number, date, name of workman, department and jobs worked upon, after which he brings down the amount of the earnings in time and value. For instance the illustration, which is the payroll slip for tally sheet No. 3, shows that No. 201 earned $3.21 for the day, made up of $2.61 day work and 60c. piece work. Time allowance is not entered in the regular time column for the reason that such time is not actually spent on the work and if entered would result in a greater number of hours which would show a smaller production per hour than was the case. The value of the time allowance is of course included in the cost of the work. After the payroll slips are made out, the foundry clerk then tears the tally sheets apart and files the slips according to symbol, by pattern, by date, while the payroll slips are filed according to workmen by date. The tally slips show no production results inasmuch as they are being rated, extended and filed while the castings are being cleaned prior to the inspection. It can therefore be seen that in the payroll file, we have the earnings for No. 201 for the day and in the production file we have, later in the day, all the information concerning his production and his time and cost to produce while the same information as to production is also on file in the office of the shipping clerk as castings on hand and ready for shipment.

The duplicate slips which are sent to the office following the inspection and which bear the number and weight of the pieces good and the number bad, are taken by the foundry clerk and

the production information transferred to the originals on file, the duplicates being marked with a letter "E" denoting entry to the original slips. As was previously stated, slips are sometimes sent direct to the office for invoicing purposes, instead of to the foundry clerk. After invoicing, all slips are handed to the foundry clerk who rapidly runs through them and when he finds any which have not been marked with the letter "E" he knows that shipment was made previous to the regular inspection, so proceeds to transfer the information they contain to the originals which will show that we have an absolute check of one slip against the corresponding slip. After all slips covering shipments made are checked over by the foundry clerk, they are filed according to symbol, by pattern, by date, for subsequent reference.

We now come to the third section of the work in question—that of making up the weekly payrolls and summarizing the costs of production. In connection with this feature of the work, it might be well to state that in order to make this method cover as much ground as possible and do away with all unnecessary recaps and distributions, an adding machine was employed, a Burroughs type being selected, which adds weight, hours and value at one operation. The machine can be arranged to make possible group and sub totals in addition to the grand totals.

It will be remembered that in the office there are two files containing—

Payroll slips filed by workmen by date and showing daily earnings.

Cost and production slips filed by symbol according to pattern by date and showing weight of good castings, hours and cost to produce—the slips covering all expense, labor being properly classified according to account number.

At the end of a payroll period, the clerk takes the payroll slips from the file, inserts in the adding machine a sheet as shown at figure 8 and lists by man number, the daily earnings under the proper day. In printing the total earnings for the week, the group total key is pressed which at the same time transfers this total to an accumulating device and when ready to take off the total of the classification, the operator presses the grand total key, which prints the amount as shown in the illustration,

PAY ROLL—WEEK ENDING March 20, 1909.

MAN NO	NAME	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	TOTAL	DEDUCTIONS	NET
				MOULDERS							
4#	Williams	320	320	320	320	320	320		1920#		
5#	Smith J.	200	200	200	200	200	200		1200#		
6#	Jones	150	150	150	150	150	150		900#		
7#	Jenkins	260	260		240	260	300		1340#		
8#	Peters	275	275	275		68	150		1043#		
9#	Wilkins	350	350	350	350	350	350		2100#		
10#	Jones	200	200	200	200	200	200		1200#		
									9703#		
				CORE-MAKERS							
12#	Lyons	325	325	325	325	325	325		1950#		
13#	Carlson	420	116	425	510	260	120		1851#		
14#	Frank	250	160	120	300	250	320		1400#		
									5201#		
				CHIPPERS AND CLEANERS							
20#	Brown	175	175	175	175	175	175		1050#		
22#	Smith T.	150	150	150	150	150	150		900#		
									1950#		
				CUPOLA MEN							
25#	Andrews	150	150	150	150	150	150		900#		
26#	Kehr	175	175	175	175	175	210		1060#		
									1960#		
				LABORERS							
30#	Jamison	125	125	125	125	125	125		750#		
31#	Lewis	150	150	150	150	150	150		900#		
32#	Jones	175	175	175	175	175	175		1050#		
33#	Green	175	175	175	175	175	175		1050#		
									3750#		
									22564#		

(8)

PAY ROLL DISTRIBUTION.

WEEK ENDING MARCH 20, *1909.* MOULDING

SYMBOL	DAY WORK			PIECE WORK			REPLACE WORK		
	WEIGHT	HOURS	AMOUNT	WEIGHT	HOURS	AMOUNT	WEIGHT	HOURS	AMOUNT
	#		#	#		#	#		#
10#	5000	100	2500	1980	33	1000	300	6	150
21#	10000	150	4500	2000	40	1200			
23#	18500	225	6075	5000	100	3000	1000	20	600
30#	75000	850	23375	5000	125	3750	2500	50	1250
32#	10000	200	4000						
33#							1000	20	400
35#	125000	1250	27500	10000	125	4000	15000	167	3340
40#	50000	500	12500						
TOTALS	293500#	3275	80450	23980#	423	12950#	19800#	263	5740#

(9)

GRAND TOTAL

293500	3275	80450
23980	423	12950
19800	263	5740
337280#	3961	99140#

Figures 8 and 9

namely $97.03 for "moulders." In this manner the clerk goes through all of the payroll slips, the record showing the earnings by workman as well as by classification of labor. To ascertain the total payroll, the clerk simply lists the group totals, presses the grand total key and the result is the payroll for the week shown in the illustration as $225.64. Names are then written in—the man number being printed by the machine through the use of an eliminating key and when the time comes for paying the men, this adding machine record is the only record used, pay envelopes filled or checks written from the total earnings as shown at the right of the sheet.

After the payroll record has been made but before the men are paid, the distribution of the payroll (consisting of all tally slips) is then made, which is done in order to make one file balance with the other. This distribution is made according to moulding, coremaking and indirect or expense labor, the moulding and coremaking labor being in turn classified according to day work, piece work and replace labor, while the indirect labor is classified according to account labor number. A sheet as shown at figure 9 is inserted in the machine for moulding labor, we will say, after which the clerk takes the slips filed behind the first symbol number and with the carriage of the machine thrown back, lists the slips showing day work moulding labor—weight, hours and value being added at one operation—laying the slips which have been listed in a pile by themselves, face down. When he has listed the last slip covering day work moulding labor, he brings the carriage towards the machine and prints the result as shown, namely 5000 No.—100 hours—$25.00 for symbol No. 10. The clerk then moves the carriage so that the figures will fall in the "piece work" column, after which he lists the piece work results (weight, hours and value), makes the addition, namely 1980 No.—33 hours—$10.00 for the same symbol and after moving the carriage, adds the replace work, the result being 300 No.—6 hours—$1.50—the carriage being thrown back when listing the slips but brought forward when printing the totals.

The foundry clerk has in one file, the tally slips which have been through the machine and which he files in a transfer drawer. He also has in a separate pile, the slips for the same symbol

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which have not been taken through the adding machine, this pile representing the core labor. These slips he places back in the current file for use when making the core labor distribution. The sheet for the moulding labor distribution is then turned up one space and the carriage moved so that the figures will fall in the "day work" column, after which he follows the procedure as above outlined for the next and all succeeding symbols. After this work is done, the columns are added vertically and the results printed as shown in figure 9, the footings being so transferred as to give the total for the week of the weight produced, the hours and the cost, as shown at "X" under "grand total." The sheet is then removed from the machine.

The clerk then makes the core labor distribution by symbol numbers, in the same manner as the moulding distribution was made and when this is done, all slips covering moulding and coremaking will have been removed from the current to the transfer drawer, leaving in the current file, tally slips covering indirect labor, which are distributed by account or shop order numbers after which the three sheets are totaled for checking against the payroll sheet for the week, which totals should agree. These distribution totals are also used for furnishing information weekly as to the production secured and the direct and indirect labor cost to produce.

At the end of the month after the last payroll distribution has been made, the monthly cost and production summary is started. The clerk takes the four or five sheets covering each of the three divisions—moulding, core and indirect labor and proceeds as follows: A sheet as illustrated for moulding in figure 10 is placed in the machine and from the four or five moulding distribution sheets, the clerk lists by symbol number, from the "day work" column, the weight—hours and amount, printing the total opposite "Day Work" by pressing the group total key. The piece work and replace information, for the same symbol, is then listed and printed as shown after which the grand total is printed opposite "Totals" by pressing the grand toal key—the illustration showing that for symbol No. 10, the total for the month is 14.100% of production at a moulding cost of 160 hours and $37.80. This same procedure is followed until all the information as shown by the four or five moulding sheets is sum-

SUMMARY OF MOULDING MONTH OF MARCH 190?.

ITEMS	WEIGHT	HOURS	AMOUNT	WEIGHT	HOURS	AMOUNT	WEIGHT	HOURS	AMOUNT
SYMBOL			10?			12?			15?
DAY WORK	10000	110	2530	50000	600	18000	40000	800	16000
PIECE WORK	3500	50	1250	10000	125	3125			
REPLACE	600			5000			5000		
TOTALS	14100#	160	3780#	65000#	725	21125#	45000#	800	16000#
SYMBOL			18?			20?			21?
DAY WORK	100000	1000	25000	2000	65	1950	6000	145	3915
PIECE WORK	10000	80	2400	2000	70	2100	2000	40	1200
REPLACE	4000			1000			1000		
TOTALS	114000#	1080	27400#	5000#	135	4050#	9000#	185	5115#
SYMBOL									
DAY WORK									
PIECE WORK									
REPLACE									
TOTALS									
SYMBOL									
DAY WORK									
PIECE WORK									
REPLACE									
TOTALS									
SYMBOL							GRAND TOTAL		
DAY WORK							825000	13000	338000
PIECE WORK							110000	1500	42000
REPLACE							80000		
TOTALS							1015000#	14500	800000#
SYMBOL									
DAY WORK									
PIECE WORK									
REPLACE									
TOTALS									

Figure 10

marized by symbol, shop order or account number on the summary of moulding. The clerk then takes this summary sheet, adds *across* the page, first the day work, then the piece work and finally

the replace work results, pressing the group total key in each instance. Pressing the group total key gives the result as shown at "X" under "Grand Total"—figure 10. After the moulding summary is completed, the clerk then makes the summary of core and indirect labor in like manner.

We now have according to symbol, the monthly production; hours and value of moulding labor; hours and value of core labor and the value of all indirect labor, properly classified. These figures are handed to the bookkeeper, who posts the total moulding labor to the moulding account No. 150, the total core labor to the core labor account No. 151 and the other items to their respective accounts. He then posts the details covering production, as shown by the summary, to symbol sheets, as illustrated in figure 11 (see entries under March).

WALKER FOUNDRY CO.

Form 41 A—1 M — PRODUCTION OF CASTINGS — Order No. — Symbol No. 18

	FOR MONTH OF	JANUARY	FEBRUARY	MARCH
	WEIGHT PRODUCED	110 000#	75 000#	114000# a
	Metal Cost	Per 100 Lbs 90 — 990 00	Per 100 Lbs — 675 00	Per 100 Lbs 1 026 00
	Molding—Pro Labor	Hours 1375 — 3437 50	Hours 857 — 2142 50	Hours 1080 — 2740 00 a
	Coremaking " "	200 — 500	140 — 350 00	210 — 540 00 a
		1575 — 393 75	997 — 249 25	1290 — 328 00
	Expense on Pro. Labor	% 110 — 433 13	% — 274 18	% — 360 80
	Expense on Tonnage	Per 100 Lbs 20 — 220 00	Per 100 Lbs — 150 00	Per 100 Lbs — 228 00
	Expense for Rigging			
	Shop Cost	Per 100 Lbs 1 85 — 2 036 55	Per 100 Lbs 1 80 — 1 348 43	Per 100 Lbs 1 71 — 1 942 80
	Commercial Expense on Pro. Labor	% 18 — 59 06	% — 37 39	% — 49 20
	TOTAL COST	Per 100 Lbs 1 86 — 2 095 94	Per 100 Lbs 1 85 — 1 385 82	Per 100 Lbs 1 75 — 1 992 00
	Produced per Molder per Day	800#	875#	1055#
	Average Pro. Labor Rate	256	256	2541
	Weight Castings Replaced	8800#	4000#	4000# a
	% " "	74	51	34
	Cost to Replace Castings			

REMARKS:

Figure 11

From the cupola reports, the metal cost is figured and entered; the material requisitions give the cost of all indirect materials used; the bookkeeper has posted all general expense items, after which all costs are gathered according to—

Direct charges.
Expenses apportionable to Direct Labor.
Expenses apportionable to tonnage produced

then brought to a controlling account "Total Cost," the rates ascertained and applied on Direct Labor and tonnage, extended and totaled as shown at figure 11, the result being the total cost to produce 114.000% for symbol No. 18 for March, namely $1992.00 or $1.75 per 100%—the production being at the rate of 1055% per moulder per day—a study of which will show the value of the statement for analytical as well as cost purposes.

A few words in closing as to disadvantages, accomplishment and the advantages. The method no doubt has certain faults show that they are more than offset by the results accomplished. To one who does not view the scheme in its entirety, the matter of rewriting would be considered a serious fault, in fact this criticism has been advanced. This consists in entering the date, man number and department on all tally slips other than the first one, for each man; the copying of the inspection results from duplicate to original and the transferring the information from the tally slips to the left hand side of the pay roll slips (man number, date, department and order numbers)—everything else being original entry. Against this can be advanced the argument that the time saved in other places more than pays for the time spent in rewriting. In connection consideration should be given to the fact that from the sending of the moulding and core orders to the shops, until the final entry on form illustrated in figure 11, the results listed are accomplished through the use of tally and payroll slips only—the bulk of the work after the entries have been made, being their sorting, filing, handling and feeding the information to a machine —a feature of the work which is not only rapid but accurate, so that the matter of rewriting is really of small moment, everything else considered.

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Another might find serious fault with the method because of the large number of slips handled in the course of a month and the possibility of losing or mislaying some of them and while it would just as consistent to advance the argument that our present bank checking system should be discontinued for the same reasons, it might be said that it is because if the unit plan that the method is so comprehensive and that the chances of losing *both slips* covering the same work is rather remote. If a slip is lost or misplaced, it is not a difficult task to find the corresponding slip and make a duplicate.

Let us see what the method really accomplishes:

1st—It acts as the means of tallying up the work done by each employee each day.

2d—It shows the time spent on all work done each day.

3d—It transfers, automatically, the work of each employee, without regard to the number of symbols or account numbers effected.

4th—It shows the work which has been started but not completed—work in process.

5th—It shows the work made and cast but not inspected—work coming through.

6th—It shows the work made, cast, inspected and ready for shipment—an inventory of manufactured castings on hand, in balance at all times.

7th—It furnishes the means of planning and making shipments.

8th—It furnishes the authority for invoicing shipments made.

9th—It furnishes the file of castings shipped, by date of shipment.

10th—It shows the daily earnings of each employee, whether paid by day, piece or premium plans.

11th—It acts as the means of making up the payrolls.

12th—It shows from day to day, the production and cost of all work, by castings, symbol or account.

13th—It shows from day to day, the amount and cost of replaced work.

14th—It provides the means for taking care of all time allowances and credits for spoiled work through no fault of the workman.

15th—It provides the means of furnishing the executive with weekly distributions of results accomplished.

16th—It forms the basis of making up monthly costs according to any classification desired by the foundryman—whether by pattern, customers work, departments, light, heavy and medium work; by workmen; floors; machines; classified weights, etc.

The principal advantages which the method possesses is that it furnishes a maximum amount of information at a consistent expenditure of time and money; it provides the executive with an excellent follow up arrangement; it reflects the conditions in the shops, at all times, both as regards production and cost, it is elastic in that it can be made to fit the requirements of any foundry or the wishes of the executive; it furnishes information which is on tap in get-at-able shape and is current and not ancient history; it furnishes clear and concise records, weekly and monthly, as to results; it enables the executive to secure his information with dispatch, owing to the rapidity with which the machine handles the figures. In short, the method provides the executive with at least one means of conducting his business, with the same care "to the machine shop door" as is usually exercised "from the machine shop door."

American Foundrymen's Association

FOUNDRY COSTS

BY B. A. FRANKLIN, BOSTON, MASS.

The subject of costs in a foundry has been a much discussed one, but alas! more popular in the discussion than in the use. Nevertheless increasing competition is making it a more and more vital subject, even if it be not yet thoroughly believed—what is really the truth—that the use of a good cost system in the foundry is a good profit-maker. The subject is eloquent in practice, but dry, unfortunately, in detailed presentation, so that most foundrymen had rather talk politics, and practise their judgment in their shops.

There is—somewhat peculiar to foundry work—if fair profits are to be obtained and unfair competition avoided — another definite reason why costs should become vital in foundry practice.

This reason is involved in the fact that in the average foundry there is seldom such a thing from the cost point of view as staple work.

Most manufacturing establishments in some degree repeat exactly the articles of manufacture and consequently expect to repeat or approximate the same article cost. In foundry work, however, the constant and unproportionate daily variation of size, shape, weight and difficulty of the different castings made cause such certain variations of cost per pound, the usual unit of selling price, that the different foundrymen bidding on the

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same job produce, in estimating, figures widely varying dependent upon their method of estimating as well as their judgment. It would seem that these very variations made it more important that the foundry should have a good cost system. But what if foundries had a standard and uniform method of cost keeping? Would it not be to the advantage of all?

Such a system must first of all be simple. It must be capable of operation with small clerical labor. It must be understandable to the practical man. And it must present to the foundryman such units of cost along the various elements of manufacture as will permit him to estimate with some assurance of approximation to the real cost when his estimate gets the job. But—what is really vital in a cost system—it should so illustrate and picture the passing situation to the practical man as to bring about reduction of cost.

This paper is presented, therefore, not with the idea of discussing cost system in general, but of presenting a method of cost system in particular, now in happy operation in several foundries, which can be operated in almost any foundry with one clerk and—of vital value in a right cost system—a method which will not only give the cost of a particular order or casting, but will so show the variation of the elements of manufacture as to help in obtaining the lowest cost of operation under the hand of a good foundryman and manager. And so to the system.

Necessarily it can best be illustrated by actual example. Form 1 illustrates the first method of foundry cost showing.

The operations are divided into the elements of

Section A.

Melting:

1 Metal
2 Fuel
3 Melting Expense

Section B.

Molding:

4 Molding Labor
5 Molding Expense—Floor and Bench separately

Section C.

6 Cleaning Labor
7 Cleaning Expense
8 Tumbling Labor
9 Tumbling Expense
10 Pickling
11 Pickling Expense
12 Sand Blasting Labor
13 Sand Blasting Expense

Section D.

14 Core Labor
15 Core Expense

Section E.

16 General Expense

In discussing this system no attempt is made to discuss the method of getting the information because such methods are simple and easily worked out.

The Basic Costs are illustrated in Form 1 which shows the weekly operation of the foundry as a whole, and Form 2 represents the cost of an actual casting. Form 3 represents the monthly foundry showing of profit and loss, offering means of proof of the foundry cost and showing the net result.

A foundry has one advantage from the cost point of view. Its operation may be considered, as in few other plants, as terminating each day. The melting starts in the morning and is over at the end of the day. This is likewise mostly true of the molding, except in case of very large castings. It is on the average true of cleaning, pickling, tumbling, etc. As nearly as possible foundry shop economy demands, and foundry work permits of a daily clean up, though, of course, some operations happen one day after the beginning.

A foundry cost might then be a daily record sheet. Weekly records, however, are sufficient generally, and the one presented is on this basis.

Note now the basic method observing Form 1.

Section A deals with Metal.

Here is shown, separately for each different mixture, of which one foundry might generally employ two or three, the weights and value of iron charged. These weights may readily be proved by

checking as each car or lot of scrap is used up. In the case of scrap made in the foundry or "own scrap," no value is put on this since it is put into the heat in an iron foundry, on the basis that scrap made on each heat will be approximately the same per cent., and what is made one day is gathered up and used the next day. The exception to this is in the case of "bad castings," charged at scrap value, and, as seen later, accounted for in casting cost.

In a steel foundry it would be necessary to charge all scrap at scrap value and credit same to particular castings.

The "metal-used" value is shown and the pounds melted, but the "metal cost" is obtained by dividing, not by pounds melted, but by pounds of "castings made"—i. e., good and bad castings. The bad castings are to be charged to the particular order as will be seen later. We thus arrive at a weekly metal cost for each mixture.

Likewise for purposes of general guidance there is shown weekly the "per cent. of good castings to melt," the "per cent. of bad castings to castings made," and the per cent. of metal disappearance or "per cent. of loss."

Now for management guidance toward general shop economy, these figures present standards and bases for striving for lower costs—viz., to make the percentage of good castings to the melt as high as possible, to make the percentage of bad castings to castings made as low as possible, and the record will quickly show that the cost fluctuates with these conditions.

And it will be found that melting and handling of metal and fuel can be done on piece work to bring best economy in metal cost.

A definite and valuable point to note is that in addition to the weekly figure of cost per pound, there is carried along the average or "period cost per pound." This is the figure to be used in cost work. The periods may be taken over any time desired, ordinarily times of no radical changes.

But there is a very vital value to be noted here, viz., the weekly figures are constantly compared with the period figures showing whether the weekly result is better or worse than the avereage, and an observation of the detail shows why. It will be found that this valuable comparsion carries through the whole method.

It will be likewise observed that throughout the costs the weekly records, set down side by side, offer easy comparsions and the real life and use of costs comes through comparsions.

And in each section it will be noted that the costs are brought down to a few vital units or percentages, and when these vary, they are significant of a gain or loss in economy of production, the reason for which can be readily observed by casting the eye up the details and observing the comparison of them.

Here is really the vital feature in this method. And these points are to be observed throughout.

Section B—Molding. Here are two elements to be considered—productive labor and expense. The expense is shown in relation to productive labor. It may be shown in relation to hours if desired, but in each class of molding labor there is generally no great fluctuation of rate per hour, and it is attempted here to show the simplest and most economical method clerically.

The productive labor and expense should be kept separately as to class of molding, as floor, bench, machine, etc., since the expense varies considerably with the class.

There may arise here some question as to whether expense should be shown by the pound or productive labor. There is, unfortunately, no absolute way of loading on expense which will withstand all argument, but a little thought and experiment would seem to show that on the whole the expenses approximately vary according to time spent in productive labor rather than by the pound.

In the matter of productive labor it is to be understood that money paid for molding each job, whether day work or piece work, is to be known and used in figuring definite casting, as shown in Form 2.

It is in this productive labor cost that the first element of variation in casting costs is to be found, the expense percentage being the same or taken as the same, except in the matter of certain direct charges or expenses to be discussed later.

Note again here the weekly and period comparison.

A word as to shop economy here would say that piece work on all molding—practical in all shops and jobs where labor agitation does not prevent—and a watchfulness of the percentage

XUM

of expense and direct charges will bring the best shop practice.

And note that the detail of expense is so given as to permit quick and sensible criticism.

Section C—Cleaning Castings. In the matter of cleaning castings there must be some division—Tumbling, Pickling and Sand Blasting are taken separately as shown below. This leaves for consideration here the cleaning of castings by other than these three methods and applies mainly to large castings, the smaller ones being generally handled by one or two of the above three methods. In the case shown no data is given for cleaning large castings, but the method is as shown in tumbling, etc.

The productive labor for economy's sake can invariably be put on piece work, though perhaps not individual piece work, and the expenses, generally small in comparsion, will be shown on the pound basis, although where confined to strictly large castings would be more truly shown in relation to productive labor, and labor in this case is almost evenly indicative of time.

In *Tumbling* the labor can best be put on piece work and will generally be done by the pound, and expenses will be shown by the pound. The case shown gives cleaning and tumbling together, since it considers only small castings. It may be said that the figures given are not intended to be exactly correct, but are merely illustrative.

In *Sand Blasting* and *Pickling* the expenses are shown in relation to productive labor, and the work can be put on piece work.

As in the other sections the detail, the weekly and the period showings are presented—really pictures of the situation.

Section D—Core Room. Here the labor can in the main be put on piece work and the expenses shown in detail. In relation to the labor by weekly and period percentages. The labor cost of cores on castings is to be obtained by the usual method.

Section E. We come finally to *General Expenses.* This is shown in relation to productive labor, the item of productive labor being those of Molding, Core Making and Cleaning operations.

It may be well to say again that the expenses shown here,

and the names by which they are denominated, must not be considered significant. These are simply the way they occurred in a particular foundry. They may be differently denominated and detailed in another foundry, and are merely considered to be illustrative of the method.

Thus we arrive at certain weekly and period basic figures of cost in the main elements in the foundry of

Metal
Molding
Cleaning
Core Making.
General Expenses.

The items of metal and expense are easily provable with the books monthly, and the labor with the payroll weekly, so that we get a proved weekly picture of the foundry situation as compared with average or period, and we get it in such detail as will show the reasons of all variations of operation, which showing, in at least four cases where the system is in operation, has brought about definite economies and reduction of cost.

We now come to the consideration of casting cost. The first element to consider is that of direct charges. In many jobs, but by no means all of them, are certain charges which it seems desirable should be charged directly to the particular order. They need in most foundry work be very small in number. These charges must essentially be gathered and held until the job is shipped and cost ready to work out.

Form 2 illustrates this final casting cost.

In all castings finished in a given period, the varying elements of unit cost would be purely the productive labor items of molding and cleaning and direct charges, the metal, fuel, melting, molding, cleaning and general expense charges being taken from the period figures on the weekly cost sheet.

Therefore, in working out the cost of a finished casting, it is essential to know of it as a particular job, the weight—and the shipping slip gives that—the molding and coremaking labor and the cleaning labor, where average rates per lb. are not used.

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The basic form furnishes the other figures of cost, and it will be seen that it is on this basis the particular costs shown are worked out.

Direct charges are added and also loss on bad castings. A record of bad castings is necessary and simple.

On bad castings the loss would depend on how far the work had progressed when discovered as bad, and what work on them had been paid for. The metal, of course, would be credited at scrap value.

By this method then it will be observed that with very small clerical labor the practical foundryman or manager gets a weekly, or daily, if he so designs, view of his foundry costs and their fluctuations which forms a definite and correct basis for accurate estimate, and he can very quickly get a particular job or casting cost by having the money spent on molding and cleaning, etc., gathered.

The Cost System settled, the bookkeeping should be made to parallel the cost system, in which case the monthly showing would be made to show as per Form 3.

Thus is obtained a complete monthly analysis. In most foundries one clerk, and almost invariably two, can operate the system as far as costs are concerned.

The method of considering certain details may be disputed and still not alter the practical operation of the system, which, as has been said, is in successful operation in several foundries now.

Thus is shown a cost system for the foundry—proved by operation—simple, cheap as to clerical labor, provable as to accuracy, presenting the main facts to the practical man for reduction purposes, giving basic figures for accurate estimate, giving accurate cost of particular casting.

It may not be inappropriate to suggest that to protect themselves and prevent as far as possible unfair competition, it might be valuable for the American Foundrymen's Association to establish a cost committee, who, with the aid of an expert, would devise and explain for the benefit of its members a standard cost system, as the Association or National Machine Tool Builders has done.

METAL—SECTION A. FORM I.

	OCT. 9		OCT. 16		OCT. 23	
	Lbs.	*Amount*	*Lbs.*	*Amount*	*Lbs.*	*Amount*
MIXTURE No. 1						
Pig Grade 1	34240	252.22	33950	253.87	25620	191.58
" " 2	32270	234.10	33290	249.68	25440	187.39
" " 3	5680	38.67	14270	97.15	6019	40.92
" " 4	36310	259.35	32070	232.65	30150	218.72
" " 5	31500	249.61	32720	259.28	25080	198.74
Bought Scrap	15900	106.47	17000	113.84	11900	79.68
Own Scrap Chillers	1275	0	1420	0	1135	0
" " Floor Scrap	7300	0	9000	0	7700	0
" " Bad Castings	10000	70.00	9000	63.00	10000	70.00
" " Gates	36100	0	34800	0	26500	0
Weekly Totals Metal Used	210575	1219.42	217520	1269.47	169535	987.03
Period Totals Metal Used			428095	2479.89	597630	3466.92
Weekly Total Lbs. Castings Made	149280		150441		116451	
Period Total Lbs. Castings Made			299721		416172	
Good Castings Made	140125		139867		109069	
Period Castings Made			279992		389061	
% Good Castings to Melt	66.5%		64.3%		64.3%	
Period % Castings Made					65.1%	
Bad Castings	9155		10574		7382	
% Bad Castings to Castings Made	6.1%		7%		6.3%	
Shop Scrap	51800		54400		43700	
% Shop Scrap						
Total Lbs. (Weekly)	201080		204841		160151	
Total Lbs. (Period)						
Lbs. Lost	9495		12679		9384	
Period Lbs. Lost			22174		31558	
% Lost	4.5%		5.8%		5.5%	
Period % Lost					5.3%	
Weekly Metal Cost per 100 Lbs.		.81	.84		.85	
Period Metal Cost per 100 Lbs.			.83		.83	

METAL—SECTION A—NO. 2. FORM I.

	OCT. 9		OCT. 16		OCT. 23	
		Amount		*Amount*		*Amount*
FUEL & MELTING EXPENSE						
Labor (Cupola Men)		45.65		44.70		33.70
" (Handling Coke & Coal)		1.80				
" (Miscellaneous)						
" (Handling Iron)		5.73		18.51		9.22
Coke		53.50		55.97		44.08
Coal		1.82				
Wood						
Fire Brick						
Fire Clay		3.20		.90		8.25
Oyster Shells		1.64		2.00		1.53
Mica Sand		2.63		2.63		2.63
Chg. from Other Depts.						
Analysis of Iron		30.00		30.00		30.00
Relining Cupola & Repairs		2.00				
Tumbling Cupola Bottom		2.90				
Crane Labor		10.95		10.75		9.30
Elevator Labor		8.66		8.52		6.93
Blower Labor		.53		.80		.44
Handling Oyster Shells						
Bituminous Facing						
Interest on Investment		10.20		10.20		10.20
Heat, Light & Power		6.15		6.15		6.15
Taxes, Insurance and Depreciation		12.42		12.42		12.42
Weekly Expense		199.78		203.55		174.85
Period Expense				403.33		578.18
Weekly Lbs. Castings Made	149280		150441		116451	
Period Lbs. Castings Made			299721		416172	
Weekly Cost per 100 Lbs.		.134		.135		.15
Period Cost per 100 Lbs.				.135		.139
Weekly Lbs. Melted to Lbs. Fuel		8.7		8.4		8.3
Period Lbs. Melted to Lbs. Fuel				8.5		8.5

MOLDING—SECTION B. FORM I.

	OCT. 9 *Amount*	OCT. 16 *Amount*	OCT. 23 *Amount*
BENCH MOLDING			
Prod. Labor	884.80	858.80	715.40
Period Prod. Labor		1743.60	2459.00
MOLDING EXPENSE ON PROD. LABOR			
N. P. Labor	10.00	10.00	5.00
Flasks, Snap Boards & Matches	6.58	6.88	1.15
Miscel. Supplies	2.42	2.80	1.09
Ladles	7.50		
Shovels & Screens	2.60		1.60
Rammers			
Chgs. from Other Depts.	23.16	10.48	
Making Bottom Boards for Mold. Machines		23.54	
Repairing Flasks			8.19
Sand	46.37	50.83	37.77
Handling Sand	6.30	6.88	6.10
Handling Weights & Bands	.47	.40	.62
Reclaiming Sand	2.30		
Parting Sand		1.65	
Interest on Investment	30.58	30.58	30.58
Heat, Light & Power			
Taxes, Insurance and Depreciation	41.94	41.94	41.94
Weekly Expense	192.22	185.98	134.04
Period Expense		387.20	512.24
% Molding Expense to Prod. Labor	21.8	21.7	18.7
Period % Molding Expense to Prod. Labor		21.1	20.8

CLEANING AND TUMBLING—SECTION C. FORM I.

	OCT. 9		OCT. 16		OCT. 23	
	Lbs.	*Amount*	*Lbs.*	*Amount*	*Lbs.*	*Amount*
Productive Labor		74.62		70.92		57.14
No. Lbs. Cleaned & Tumbled	134462		139089		105203	
Period Lbs. Cleaned & Tumbled			273551		378754	
Cost per 100 Lbs. (if day work)		.056		.053		.054
Period Cost per 100 Lbs. (if day work)				.054		.053
CLEANING & TUMBLING EXPENSE						
Supplies						
Overseeing		2.45		.40		1.93
N. P. Labor				.40		.75
Chg. from Other Depts.				.65		2.02
Tumblers				4.00		
Stars for Tumbling						10.00
Interest on Investment		5.44		5.44		5.44
Heat, Light & Power		55.44		55.44		55.44
Taxes, Insurance & Depreciation		8.40		8.40		8.40
Weekly Gross Expense		71.73		74.73		73.98
Stars Used in No. 3						
Weekly Expense		71.73		74.73		73.98
Period Expense				146.46		220.44
Weekly Expense Cost per 100 Lbs.		.053		.053		.07
Period Expense Cost per 100 Lbs.				.053		.058
Weekly Total Cleaning & Tumbling Cost		.109		.106		.124
Period Total Cleaning & Tumbling Cost				.107		.111

PICKLING—SECTION C—NO 2. FORM I.

	OCT. 9		OCT. 16		OCT. 23	
	Lbs.	*Amount*	*Lbs.*	*Amount*	*Lbs.*	*Amount*
Weekly Prod. Labor		20.70		19.82		13.10
Period Prod. Labor				40.52		53.62
Weekly Lbs. Pickled	62818		65600		36220	
Period Lbs. Pickled			128418		164638	
Weekly Cost per 100 Lbs. (if day work)		.033		.030		.036
Period Cost per 100 Lbs. (if day work)				.032		.034
PICKLING EXPENSE						
N. P. Labor		1.75		.75		1.10
Oil of Vitrol		2.06				
H. F. Acid		23.92		15.28		10.51
Acid Spigots						
Chg. from Other Depts.				1.88		1.48
Interest on Investment		3.40		3.40		3.40
Heat, Light & Power		3.08		3.08		3.08
Taxes, Insurance & Depreciation		2.53		2.53		2.53
Total Weekly Expense		36.74		26.92		22.10
Total Period Expense				63.66		85.76
% Dept. Expense to Prod		177.5%		135.8%		168.7%
Period % Dept. Expense to Prod. Labor				155.8%		160%

SANDBLASTING—SECTION C—NO. 3. FORM I.

	OCT. 9		OCT. 16		OCT. 23	
	Lbs.	*Amount*	*Lbs.*	*Amount*	*Lbs.*	*Amount*
Weekly Prod. Labor		4.37		6.06		4.61
Period Prod. Labor				10.43		15.04
Weekly Lbs. Sanddblasted	10200		11800		8100	
Period Lbs. Sandblasted			22000		30100	
Weekly Cost Per 100 Lbs. (if day work)		.043		.051		.057
Period Cost per 100 Lbs. (if day work)				.048		.05
SANDBLASTING EXPENSE						
N. P. Labor				.61		.41
Supplies		.75				
Sand		1.10		1.10		1.10
Chg. from Other Depts.						
Interest on Investment		6.80		6.80		6.80
Heat, Light & Power		15.40		15.40		15.40
Taxes, Insurance & Depreciation		1.38		1.38		1.38
Total Weekly Expense		25.43		25.29		25.09
Total Period Expense				50.72		75.81
% Dept. Expense to Prod. Labor		581.9%		417.4%		544.2%
Period % Dept. Expense to Prod. Labor				486.3%		504.2..
Prod. Labor				486.3		504.2%

CORE DEPARTMENT—SECTION D. FORM I.

	OCT. 9		OCT. 16		OCT. 23	
	Lbs.	*Amount*	*Lbs.*	*Amount*	*Lbs.*	*Amount*
Productive Labor		233.55		220.65		165.65
Period Prod. Labor				454.20		619.85
COREMAKING EXPENSE						
Foreman		24.00		24.00		24.00
Tending Ovens		12.65		12.63		7.87
Inspecting Cores		19.14		18.08		13.89
Storing Cores		12.10		11.78		9.62
General Labor		17.11		15.16		13.37
Sand		21.80		18.32		25.89
Coke		2.92		2.45		1.56
Coal		6.44		5.58		1.73
Rosin						
Miscel. Supplies		5.54		3.00		1.55
Flour						
Interest on Investment		13.67		13.67		13.67
Heat, Light & Power		1.43		1.43		1.43
Taxes, Insurance & Depreciation		21.61		21.61		21.61
Weekly Coremaking Expense		158.41		147.71		136.19
Period Coremaking Expense				306.12		442.31
Weekly % Expense to Prod. Labor		67.8%		66.9%		82.3%
Period % Expense to Prod. Labor				67.4%		71.3..
Labor				67.4		71.3%

GENERAL EXPENSE—SECTION E. FORM I.

	OCT. 9	OCT. 16	OCT. 23
	Amount	*Amount*	*Amount*
Executive	27.00	27.00	27.00
Foreman	48.00	48.00	48.00
9396—2—B			
N.P. Labor	12.74	25.08	16.67
Clerical	49.00	49.00	49.00
Supplies	.87	1.43	1.85
Chg. from Other Depts.	15.55	26.00	27.75
Scrap	45.38	3.57	13.98
Gas	1.00	1.00	1.00
Inspecting	63.20	64.59	42.65
Injured Employee			5.00
Tending Pattern Safe	11.47	9.60	7.20
Brooms			.75
Interest on Investment	11.56	11.56	11.56
Heat, Light & Power	22.59	22.59	22.59
Taxes, Insurance & Deprecation	310.45	310.45	310.45
Weekly General Expense	618.81	599.87	585.45
Period General Expense		1218.68	1804.13
Weekly Prod. Labor	984.49	955.60	790.25
Period Prod. Labor		1940.09	2730.34
% Expense to Prod. Labor	62.9..	62.8..	73.9
o Expense to Prod. Labor	62.9%	62.8..	73.9
..o Expense to Prod. Labor	62.9	62.8%	73.9
..o Expense to Prod. Labor	62.9	62.8	73.9%
Period % Expense to Prod. Labor		62.8%	65.8%

INDIVIDUAL JOB OR CASTING COST. FORM 2.

Date, Oct. 12

150 Blocks—J. & S. Co.—850 Lbs.

	Amount	*Unit Cost*	*Value*	
Metal	850	.83 per 100	7.05	
Melting Expense		.139 per 100	1.18	
Molding			3.00	
Molding Expense		20.8%	.62	
Cores			.50	
Cores, Expense		71.3%	.36	
Cleaning & Tumbling		.053 per 100 Lbs.	.45	
Cleaning & Tumbling Expense		.058 per 100 Lbs.	.49	
Sandblasting				
Sandblasting Expense				
Pickling		.034	.29	
Pickling Expense		160%	.46	
General Expense		65.8%	2.13	
Spoiled Work			.42	3 spoiled
Total			16.95	
Cost per Lb.			.0199	

Note.—In this case no selling expense is added, as it might be in many cases.

MONTHLY SHOWING. FORM 3.

Quick Assets.

Cash
Accounts Receivable

Permanent Assets.

Real Estate
Building
Machinery

Raw Material on Hand.

Pig Iron (Credit amount used each week as per costs and charge to Mfg. Acct.)
Scrap

Manufacturing Acct. (See analysis below)

Expenses undivided (Meaning expense supplies not used)

Quick Liabilities.

Accts. Payable

Permanent Liabilities.

Capital
Depreciation
Surplus

Detail of Mfg. Acct.

Dr.

Inventory at start of Castings in process
Metal, Labor, Expense } each month

Cr.

Sales
Inventory of castings in process 1st of each month.

Balance Profit or Loss monthly.

American Foundrymen's Association.

PYROMETRY IN THE ANNEALING ROOM

BY S. H. STUPAKOFF, PITTSBURG, PA.

The satisfactory production of Malleable Iron Castings depends to a large extent upon subjecting the hard castings to a suitable heat treatment which effects a transition of the originally white iron into the well known soft gray-black variety with surprisingly different physical qualities. It is in the latter state in which it is brought on the market, and is perhaps the only one of its different phases that is known by the user. The change from hard white into soft gray-black, or "black heart" iron, as it is often called, is effected by a prolonged reheating of the castings, commonly known as the "annealing" process. The annealing or softening of the material is really the principal object sought. However, this softening is only coincident with other chemical changes that take place during this process, which are in truth the primary results of reheating the hard white iron for a specified length of time within definite limits of temperatures. Other physical changes that occur at the same occasion, such as increase in ductility, elongation, bending movement, tensile strength and malleability,

are of even greater value and importance to the subsequent application in the arts of this excellent variety of iron.

It is not the intention to dwell here upon the composition of malleable iron mixtures, as they have been discussed at length by acknowledged authorities on the subject. Suffice it to state that the mixture consists essentially of a low carbon iron with about .70% to 1.00% Silicon. This iron on melting under suitable conditions will after casting turn out with a silvery white fracture, and extremely hard and brittle. In this condition it is almost absolutely useless for any purpose. Nearly the whole of its carbon contents is present in the combined state, i. e. chemically combined with the iron. The object of the annealing process is to break up this combination and to transform the combined carbon into a non-crystalline graphitic state. As such it will then be present in the iron merely as a mechanical mixture and provided all other conditions are equally favorable, the result will be a malleable cast iron with its well known good qualities.

Hence, during the annealing process we are breaking up a chemical combination of iron and carbon, opposing hereby the gigantic forces of chemical affinity to the subtle agent of heat. Yet, just as the constant dropping of water will hollow the hardest rock, so will the incessant attack of heat pull and push about the infinitely small particles of unrelated materials until each occupies its proper abode. This, however, is by no means as simple a process as the annealing or hardening of tool steel, whereby the carbon and iron-carbon contents are merely changed from one allotropic state into another, and which might be compared for the sake of illustration to changing liquid water into solid ice or into its gaseous form—steam. Either one of these results may be achieved within a comparatively short time by rigidly observing the conditions which are necessary to place the molecules of the material in their desired states of allotropy. There is much more accomplished in the annealing process of malleable cast iron, and the changes aimed at during this operation are of a much more radical nature, so that

it should not be strange to note that it involves the factor of time as well as that of high temperature.

Researches on the constitution of iron and steel are as recent as 25 years ago, and lie within the memory and practice of most manufacturers of the present day. Little, however, was dreamt of the nicety of equilibrium to which the constitutents of our materials must be poised in order to obtain the best results in our products. The knowledge of what can be accomplished by judicious treatment has spread like wild fire throughout the world, manufacturers and consumers alike being fully aware that no product can find a place in the open market of today, unless it comes within the narrow limits of the most rigid of specifications. The manufacturer is compelled to meet the just demands of the wide awake buyer, who is as well, and often better, informed of modern possibilities as he is.

We know that no radical change from the state of combined carbon to that of graphitic carbon can take place in any of our numerous iron compounds below a certain place in our temperature scale. And we know likewise that the same transition cannot be accellerated after a certain highest point of the scale has been reached. The definite region where such a change commences to become noticeably active is known as the critical range. Its location varies slightly up or down the scale, according to the composition of our material, though in iron and its compounds it depends principally upon its higher or lower percentage of carbon. It is safe to say that its lowest limit does not fall very far below 700° Centrigrade or about 1300° Fahrenheit, and its upper limit does not exceed 900° Centigrade or about 1650° Fahrenheit.

It is quite true that there exists a constant transmigration and rearrangement of the smallest particles (the molecules) of our iron compounds at far lower, and perhaps at all temperatures; but they are of no moment to the producer nor to the user of malleable iron. They may be of scientific value, but they are certainly too insignificant to be taken seriously into consideration in practice. This is far different when we come to deal

with some of the physical changes which take place in the course of time in some of our steels. And we may refer particularly to some special finished products used for electrical purposes, as permanent magnets. It is well known that these assume their permanency only after a considerable lapse of time—several months, which again depends upon conditions of temperature at which they were kept to age them. And it is equally well known that this so called, ageing of steel, can certainly be effected at as low a temperature as that of boiling water. However, a change of the molecular arrangement of the constituents of iron or steel, as that of changing one form of carbon or iron, or their compounds, into other allotropic forms, can only take place at considerably higher temperatures.

These remarks are given here merely to show that after all we are not dealing in our commercial iron and steel with as exceedingly simple bodies as they are ordinarily assumed to be. In fact, as soon as we attempt to delve into the profound depth of their molecular constitution, as soon as we lay bare the laws of their existence and try to explain the phenomena we see, we meet with almost unsurmountable obstacles and perplexing complications.

And as the course of the practical man lies along the path of all these uncertainties, is it not most natural that in his dilemmas he should call in the aid of the scientist for his enlightenment? The first advice that he receives is to abandon his old hit and miss methods. All steps in the manufacture of his products must be conducted upon the basis of correct principles. There is no possible chance of attaining the desired ends if it is attempted to accomplish miracles, or what is the same, to attain definite results by means which are contrary to natural laws.

The manufacturer of malleable cast iron has long since submitted to the necessity of relying upon the services of a trustworthy metallurgist, who selects his mixture from among various grades of iron, calculates the necessary quantities of each, basing his work on a careful chemical analysis of the raw

materials as well as of the product. But the conscientious chemist is fully alive to the fact that the best brands of iron, the most suitably compounded mixture and the most carefully executed analysis alone will not result in a good product. There is the melting process in all its details to be duly taken into consideration, and this is usually left to the "judgment" of the melter. Last, not least, we have in the annealing process one of the most important stages in the production of malleable iron which governs the physical qualities and the commercial value of the product.

And these all important stages of heat treatment of malleable iron are left—even now—in many establishments, to the fallacious personal judgment of a few operators, whose principal qualification is that they have grown up in the business. Who would question the fact that the success or failure of each individual heat in foundries conducted on these lines depends almost exclusively upon the personal skill, the good will, state of health, mind and disposition of a few trusted employes?

The *Electrochemical and Metallurgical Review* brought out in October 1906 an editorial, that fully covers the situation. It is an exposition of close observation and a masterpiece of deep thought, common sense reasoning, and full of expression, which the writer recommends to the careful consideration of all the manufacturing world. It says:

"The practical self made man has acquired a faculty of feeling or perceiving my intuition whether his process works correctly or not. Such knowledge is stored in him and it will die with him. This fact makes him liable to underestimate or wholly misunderstand the value of scientific methods. This is his mistake. But in many cases if we see what has been accomplished simply by consistent hard work with rule of thumb and try and miss methods, we can not but admire the man who did this work. Yet it remains a self evident truth that we must get away from the rule of thumb, and must use instead exact scientific principles. The times have marvelously changed, and while we must admire the "practical man" of the past,

the future belongs to the man whose work is based upon scientific principles. The practical furnace man in a metallurgical works of the past saw with his eyes whether the metal was at the right temperature. He did his work faithfully and successfully, but when he left the plant his knowledge went away with him. Now in the period of pyrometers, a works is enabled to get a permanent record of the right succession of temperatures during a process. It is thus possible to repeat a successful process from the written record after success has once been established—and the plant is independent of the individual man. This illustrates clearly the industrial progress which has been made, and which is wholly the result of scientific progress."

And this is the very point aimed at in this paper. It is the intention to impress upon all interested parties that, since trustworthy instruments are available for following up the various stages of the heat-treatment of our materials, we should use them freely and intelligently and thereby become independent of the personal factor. Even the best of such services, most faithfully given, can not be free from mistakes. And errors, whatever their cause, and whatever their extent, cost more or less money. This money is lost by the manufacturer alone, while the wages of the mechanic go on as if nothing had happened. And the same pleasant relationship prevails until one or the other of the two parties concerned tires of it and steps out. Then there is change for worse or better. A new hand steps in, and he is given a chance for a month or more—at the expense of the manufacturer—to become acquainted with the methods, the appliances, the working of the furnaces and the running of the plant. After that it depends in part upon his experience and his skill, but especially upon his "good luck", whether there is a material improvement in the quality of the product and in the profits of the business or not.

But why depend upon the fallible judgment of the individual if there is no necessity for it? There is ample opportunity for the mechanic to make good use of his skill in other

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directions than "guessing" at the most suitable thermal conditions during the various stages in the manufacture of his products. This task lies not within his province, it extends beyond the limits of the unarmored senses of man. Man's senses were never intended for such conditions, they were not developd for it, they are not adaptd to it, and they are not fit for it.

The easiest manner to prove these assertions to you by your own experience may be by recalling a few well known examples from physics, which every one of you has learnt while still at school. Step from broad day light or from a brightly illuminated space into a dimly lighted room, and all things appear indistinct, whereas you can recognize without trouble even the smallest details if you enter the same room from the dark. Touch in a Turkish bath room with your bare hands or feet substances of different natures, like straw matting, woodwork, stone flooring or metals, and you will experience remarkably different sensations. They may lead you to think that all have widely differing temperatures, whereas the application of a thermometer to either one of them will show you that the temperature of all is exactly alike. Make the same experiment in a refrigerating room, and you will experience sensations of an exactly opposite nature. Fill three basins with water, one at 32°, the second at 90° and the third at 160° F. Place both hands in the basin with water at 90°. After a short while you will not be conscious that your hands are in contact with anything; you will feel no heat. Then plunge one hand into the cold water and one into the hot, keep them there until they have assumed these temperatures, and then change both hands over into the water of 90°. Now, if you were to believe your senses, one of your hands would make you believe that the water is hot, and the other one that it is cold.

Example after example of the same or similar nature might be cited, every one of which would furnish you with positive proof of the fallacy of our senses; but I believe that the above, which have been selected from the ranges within our natural state

of condition, should be sufficient evidence to you that it is entirely beyond us to approach with our judgment even approximately within reasonable limits of conditions that lie out of reach of our unprotected or unarmored organs.

This object can be attained only by the employment of suitable physical instruments, and in our present particular case by the judicious use and correct application of high temperature measuring instruments. We can make our selection from among a number of different types.

The *Siemens Water Pyrometer*, which was perhaps the first practical instrument for the purpose, is somewhat out of date, but still as good as any if used intelligently. It is not as convenient as the more modern types of pyrometers; it gives no permanent indications of prevailing temperatures; it can not be handled easily by an ordinary workman, and it takes from 15 minutes upward to determine the temperature desired. But, when carefully handled, its reliability comes fully within admissable limits of malleable iron practice, and it is certainly reasonable in price.

Seger's Cones or *Wiborgh's Thermophones* may be used in annealing furnaces to some advantage in cases of emergency, if no better means are available. They will serve to give an approximate indication of the time when the highest admissable temperature has been reached. They are only good for a single application and must then be replaced by new ones. But they are cheap and they can be handled by an ordinary workman. It is good practice to keep a few sets of these little tell-tale cones on hand, whether there is an immediate use for them or not. Conditions are sure to arise sooner or later in the best regulated establishment when it will be considered a blessing to be able to lay one's hands on them.

Mercury Thermometers are now obtainable reading up to nearly 1000°F. They are made of a special grade of (Jena 59^{III})

hard boro-silicate glass, and are nitrogen filled. They lie below the range of malleable iron annealing furnaces, but they may be useful for regulating the temperatures of core ovens, and they are sometimes quite serviceable for application in some stacks and flues. They are made in a number of different shapes and when equipped as mechanical fixtures they are adapted to be permanently applied suiting various conditons. It is obvious, that, owing to the fact that they are partly constructed of glass, careful handling is necessary to avoid breakage.

Mechanical Thermometers form a class of heat measuring instruments distinct by themselves. They are mostly constructed upon the basic principle of the unequal expansion of two different metals when exposed to varying degrees of temperature. The expansive force is transmitted to a pointer which moves over a graduated scale just like the hand of a clock or that of a pressure gauge. These instruments are constructed entirely of metal, excepting that the pointer and dial is covered by a disc of glass. They are rugged, are not easily damaged, reliably accurate within fairly reasonable limits, and suitable for indicating temperatures up to about 600°F. They are therefore adapted for use in Malleable Iron foundries in core ovens which are well under control, in pitch and enameling furnaces, in high and low pressure steam lines which may be used for drying, for heating or for any other specific purpose that comes within their range.

It may not be out of place to insert here parenthetically that *"Thermometers"* include all instruments for any range of temperature from the lowest (the absolute zero) up to the boiling point of mercury (676°F.), while others that are adapted for ranges higher than this point are usually designated as *"Pyrometers."*

Expansion Pyrometers are constructed upon the same general principle as the foregoing class of Mechanical Thermometers, but as their name implies, they are intended for higher ranges of temperatures. They enjoyed for many years quite an extensive distribution and use in many branches of the industries,

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but within the last two decades they were compelled to make room for the more modern types of instruments. When used for short periods of exposure up to within moderately high limits they give reasonably close indications. The claims usually made for them should be accepted with caution, and it is always advisable when using them in practice, to remain considerably below their given maximum to avoid permanent setting of their vital parts. Provision is made in most instruments of this type to take up a permanent set by means of adjusting screws. However, before these means for readjustment are resorted to it is necessary that the instrument be allowed to cool to normal temperature.

Electric Resistance Pyrometers are of modern construction. They are exceptionally sensitive to small variations of temperatures, and they give very close and trustworthy readings when judiciously used within their limits. They must not be exposed to temperatures above 1,200°C., as this would cause a permanent change in the resistance of their vital parts, necessitating recalibration. Their usefulness extends consequently over the whole range of annealing temperatures, but not high enough to be practical for measuring the temperatures of iron, and steel and their alloys in the molten state. The active portion of these pyrometers, consisting of a coil of fine platinum wire, must be projected against the action of furnace gases by an impermeable sheath or covering. And as there are no highly refractory substances which will accomplish this excepting some special porcelains or pure silica, which are all of a brittle nature, it stands to reason that these instruments must be carefully handled. This, however, is a feature present in all high class temperature measuring instruments that are directly exposed to the sources of heat. It is unavoidable, and this alone should be no good reason that they be condemned and barred from use in industrial establishments.

Thermo-electric Pyrometers compose another distinct class of modern high temperature measuring instruments. They offer many advantages over others of their kind. They are certainly the simplest in construction, they are easily handled and easily

applied, and they can be used in numerous instances where it would be impossible to make use of pyrometers of any other type. The fact that almost any two metals of different nature or of different composition, when joined, will cause the appearance of thermo currents upon heating this junction, has induced many enterprising firms to bring instruments of this kind upon the market which are supposed to offer many advantages over others that have earned deservedly universal reputation. However, in the majority of these imitations (?) the fact has been overlooked, that the physical quality of changing heat waves into electrical waves alone, even if applied to practice by the most skillful mechanic, is not sufficient to product a reliable scientific instrument for "measuring temperatures". It is true, there are some that are quite trustworthy within their specified limits, but for most of them entirely too much is being claimed. This does more harm than good, and it is quite frequently the cause of arousing suspicion as to the reliability of the better class of instruments of their kind. There is no question that it would contribute considerably to the general spread of practical pyrometry, if the distribution of such faulty instruments would receive less encouragement. The writer has in his possession a report from the highest Authority on such matters on the test of one particular make of these thermo-couples, which, by the way, are extensively sold in this country, that says among other things:—"THEY ARE NOT AT ALL SUITABLE FOR THE MEASUREMENT OF TEMPERATURES". There is no doubt that our own highest court of appeals in such matters, the Bureau of Standards, at Washington, D. C., would corroborate the above if their opinion should be solicited.

To a certain extent it may be pardonable if such errors are committed unknowingly by men who have the best intentions but not the necessary scientific training. They might be told to leave well enough alone, to stick to their last, and be cautioned that "A little knowledge is a dangerous thing" etc.; but if men who are supposed to know better, and who undoubtedly do know it, use these means to further their own ends—possibly to their way of thinking "The end justifies the means"—it would seem timely to call a stop to their methods.

An exploit of this kind smacks too much after the methods of charlatans or fakers, whose principle object it is to find the greatest number of dupes who will buy their gold bricks. Surely nothing but the most conscientious conviction and honesty, and absolute truthfulness and accuracy has a tolerable show of lasting acknowledgement and of unlimited credit in scientific pursuits. All pecuniary considerations must be cast aside, or at best be only of a secondary nature, else the greatest achievement in science will not find the recognition it may be justly entitled to.

There are an amazingly small number of materials among the seventy odd elementary substances and their innumerable combinations that, when connected in pairs, will meet all the requirements of a good thermo-electric pyrometer. The best so far devised is that consisting of one wire of pure platinum and one of pure platinum alloyed with 10% rhodium as suggested by Professor Henry Le Chatelier of the School of Mines at Paris, France. It is considered by all physicists the standard of measurement for high temperatures up to about 3000°F., and it unquestionably supercedes all others in constancy and accuracy from about 300° F. to its upper limit.

Among thermo-electric couples there may be further mentioned the Iridium-Ruthenium and the Platinum-Iridium couple. The former can be used for temperatures higher than 3000°F., but it is exceedingly brittle and therefore not well adapted for use in industrial works, though it is undoubtedly of a high scientific value. Platinum-Iridium couples have a smaller range than Le Chatelier's Platinum-Rhodium couples. This is owing to a change of their thermo-electric constants which occurs at about 1800°F. on account of the volatilisation of the Iridium that commences about at this stage. Trustworthy for lower ranges of temperatures are Copper-Constantan, Silver-Constantan and Iron-Constantan thermo couples. (Constantan is an alloy of 60% copper and 40% Nickel.) Neither one of these latter couples, however, can be seriously recommended for use above 650°C. or 1200°F.

Optical Pyrometers are constructed upon the laws of relation-

ship between heat and light. They are in fact instruments that measure the degree of light that is emitted by a hot body, and this is transposed by some convenient means into degrees of temperature. It would seem that this method offers a decided advantage over other instruments made for the same purpose, in as much as the instrument is not required to be brought in direct contact with the source of heat. But this property alone, if not combined with simplicity of construction, ease of handling and maintenance would not fill the requirements of every day shop practice. At the present time there are but few commercial optical pyrometers that possess these qualities combined, and most of them remain therefore so far only excellent laboratory instruments, which in the hands of a careful operator give surprisingly accurate results within ranges that are far beyond the reach of other instruments for the same purpose. There are, however, a few types of optical pyrometers made that are very simple in construction and easy of manipulation, which may be used by almost any man of ordinary intelligence. But it should not be forgotten that due allowance must be made in all optical pyrometers for personal errors of observation which vary sometimes considerable with different, and occasionally even with the same individual observer.

Radiation Pyrometers, like optical pyrometers are used at a distance from the source of heat that is to be measured. They are therefore not subject to destruction by fire or furnace gases and will last indefinitely if guarded against mechanical injury. No part of the instrument is ever heated above 80°C. or about 180°F. Their construction is based upon the principle of measurement of the total radiations of heat—not light, as in the foregoing—of substances located under conditons known as those peculiar to a black body. The heat rays are collected by a mirror located within the instrument and, then concentrated into a focus where the hot junction of a sensitive copper-constantan couple changes them into electrical waves, the electromotive force of which is subsequently measured by a sensitive d'Arsonval galvanometer. The scale of this indicator is expressed directly in degrees Fahrenheit or Centigrade as the case may be, and there is no transition of the values into any other denomination neces-

sary. This makes the instrument a very convenient contrivance for the direct determination of the highest attainable temperatures.

Miscellaneous Pyrometers based upon the laws of expansion of air, the dilution of liquids and gasses and the variation of the viscosity of gases—all under different conditions of temperature —have also been made, and have found some application in practice, but in a comparatively limited way only. The graduation of these instruments is purely empirical, as they are somewhat cumbersome, more or less complicated and expensive. It is certain they have not found much favor in annealing practice, and they are rarely—if at all—found in malleable iron or steel foundries.

Fusible Alloys, made of precious metals, have been occasionally employed for the determination of high temperatures; but, excepting in dentistry, their application in practice has been almost entirely abandoned. Therefore it would appear that merely mentioning them in this place should answer our purpose. This ends the list of high temperature measuring instruments. All have had their share of fair trials, some have found practical application in our industrial establishments, and, though it can not be said that our tests have been concluded, there are at the present but a remarkably small number of types that have gained a solid foothold in our factories with fair prospects for permanence.

The equipment of all mechanical and electrical pyrometers includes necessarily a suitable indicating or recording device. That class of instruments mentioned as expansion and contraction pyrometers and thermometers have their mechanism for moving a pointer over a graduated dial directly connected to the operative portion of the end exposed to heat. The pointer of recording instruments of this type, which carries a writing pen or pencil is connected likewise, and the latter bears permanently against a sheet of paper usually rotated by clockwork, and arranged either as daily or weekly records. The expansion and contraction of the substances which form the vital parts of these instruments furnishes ample power to admit a permanent contact of the writing pen with the paper without introducing material error. The result is therefore a continuous uninterrupted line which

represents graphically the conditions of temperature with relation to time of the entire heating process.

In electrical pyrometers we have but a very small amount of power at our disposal for moving a pointer over a scale and for recording the corresponding temperatures. Resistance pyrometers are used in connection with a Wheatstone bridge to determine the change in resistance of its sensitive portion which is dependent upon its temperature. Millivoltmeters serve mostly, in thermo-electric pyrometers, for the measurement of the electromotive force of the thermo-currents which in turn stand in certain relationship to the temperature prevailing at their points of junction. Radiation pyrometers which are also constructed upon the thermo-electric principle have the same means of measurement.

Recording instruments for these pyrometers embody the same electrical apparatus as their indicating instruments, and besides this a clock work with paper and style imprint movements. In recording instruments for resistance pyrometers, subsiduary currents from batteries or motors may be used for furnishing any amount of power that may be necessary for the pen, paper and imprinting movements. It is thus possible to produce uninterrupted continuous line diagrams on the record paper. In recording instruments for thermo electric and radiation pyrometers, however, we are solely dependent upon the feeble thermo electric currents for operating the movable portions of our galvanometers or millivoltmeters, and consequently we are compelled to rely upon these alone to produce permanent records in this class of instruments. This object can only be attained by resorting to periodic depressions of the style bearing the indicating needle. In this manner the records become line drawings that are composed of consecutive markings, which, according to the specific arrangement used, may combine either into a continuous line, or be represented by a series of dots which show continuity and dependency from each other in the completed diagram.

The advantage of continuous *autographic records,* which give a truthful and lasting representation of all details accompany-

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ing the entire course of a process of heat treatment must be apparent. It furnishes the means to trace irregularities or negligence in the running and attendance of our furnaces and ovens, it serves to detect the causes of faults in the heat treatment of our materials that result invariably in unsatisfactory products, it suggests to us what steps are to be taken to correct such faults and to improve the quality of our products and it makes it possible to systematize our entire methods of heat treatment, removing the responsibility from the overburdened shoulders of our expert operators. It makes us independent from them and allows us to place such responsibility without hazard and with far better chances for continued future success into the hands of green—though conscientious—common laborers. A series of records illustrating the heat treatment of our materials, intelligently marked with notations as to the physical qualities of the resulting products are unquestionably the best, if not the only means or the most reliable method for predetermining qualities that will be obtained under certain conditions. For establishing set rules as to the most economical, the most efficient and the most reliable mode of running our various furnaces and ovens that will give us the best possible guarantee of definite results, and eventually for repeating previous processes which have proven satisfactory in imparting the resulting product with the most desirable good qualities.

This can not be readily attained by the use of an indicating instrument alone, unless its indications are noted down at regular short intervals by a trustworthy employee who has been especially detailed for this purpose. Non-recording instruments, however, are a necessity in the hands of men in charge of our furnaces or ovens. They will serve them as reliable guides and advisors that will furnish correct information of existing conditions, and they are their only means of reference as to what they are to do in order to strictly follow given instructions.

The *principal use that* pyrometers find in malleable cast iron foundries is for regulating the temperature of annealing ovens, and especially for regulating the temperature of the malleable castings themselves during the anneal. It is all-important that

we make a clear distinction between these two intimately related heating processes, for it is well understood that the temperature of the furnace does not represent the temperature of its contents. There may be wide variations between both, and again, they may approach each other very closely. It is neither at all likely that the temperature in an annealing oven is uniform throughout, though in some exceptional good instances—as in pit furnaces—there may exist no greater variations than 50°F. in its various portions. This, however, is a rare occurrence, it is found more frequently that different portions of the same oven vary from 100 to 300°F. and upward. It is quite feasible that under such conditions no satisfactory results can be obtained in the product, in which uniformity is one of the principal requirements. This is the first application in which we can make good use of our pyrometers for equalizing the temperatures in our ovens as closely as may be. Prevailing conditions are reliably indicated by applying one or more pyrometers at different portions of the installation, and such conditions being once established and known, it becomes an easy matter in the hands of a practical furnace man to regulate his oven temperatures by enlarging some of the flues or by chocking others, by opening or closing dampers, by increasing or decreasing the supply of fuel or air or the draught in the stack, by luting up cracks in the walls or around the doors, and in other ways for which no set rules can be given, but which will readily suggest themselves in practice.

In connection with the above it may be appropriate to call attention to a mistake which is frequently made when pyrometer readings are taken of furnaces of this or any other description. That is, such readings are usually taken for granted as representing the true temperature of the furnace, regardless of the fact whether the flame of the fuel plies against the sensitive portion of the instrument or not. This is wrong, and apt to lead to grave errors. We would expose our pyrometer to the direct action of the flame if it should be our intention to ascertain the temperature of this, but we must guard it against its direct influence if we wish to establish the state of the interior of our furnace. And, as it takes rarely more than a fraction of a minute

to take such a reading, it will prove safest to turn off our fires while making tests of this nature.

We know that it takes a long time before our annealing boxes and their entire contents "come up" to the heat of the oven. The oven may have had the right temperature many hours before even the most exposed portions of the boxes approach the same. In uniformly working ovens after a sufficient lapse of time, and by judicious firing, we succeed in bringing both to the same temperature, but if we wish to prevent any portion of our anneal from overheating we are compelled to keep on firing at a slow rate and at a low heat.

The best method of annealing consists in heating the charged material as quickly as possible to the maximum temperature compatible with the process, to keep it at this stage for a sufficient length of time to effect the desired molecular change and then letting it cool down slowly.

A considerable saving in time and in fuel may be effected by pushing the firing in the first stages to its upper limit, provided due care is being taken to make full use of the heat derived from the combustion of the fuel for heating the charge, and not sending it out of the stack. This object is rarely attained in the fullest measure. It can only be accomplished by causing complete combustion of the fuel either outside of the oven or at least before the unburnt gases have had a chance to come in contact with the large quantity of cold material that is massed up in its interior. It is surprising to learn how little economy is exercised in the use of fuel in ordinary annealing practice, or to put it more plainly, how much fuel is recklessly wasted. No knowledge of the higher mathematics is necessary, only a little plain arithmetic to show the percentage of the developed heat effectively used and that of the heat lost. This is a question worth looking into. It is dollars and cents to the manufacturer.

It is true, such problems can not be solved within a day, and perhaps not in a week, but it can not be questioned, they are not beyond satisfactory solution. It is also acknowledged that the

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"mere possession" of the best of all necessary instruments for checking and regulating thermal process is not sufficient. It requires their intelligent and correct application, and a fair understanding of the construction, and value of their indications.

The best service in this direction can be expected only from a trained metallurgical engineer who must be at the same time an experienced specialist in combustion and in the heat treatment of materials. However, much is to be gained without the valuable aid of such an advisor, by the intelligent application of the various excellent instruments now obtainable for the purpose, such as draft gauges, gas analysis apparatus and pyrometers. Quite frequently a single one of these instruments may render material aid in improving existing conditions; as the draught, the composition of the gases of combustion and its temperature are closely related to and dependent upon each other. And as most practical men—by which I mean especially the manufacturers—are averse to equipping their works with a variety of physical apparatus, they may be satisfied as a rule with the results obtained from the use of a reliable pyrometer.

It has been pointed out that large variations in temperature are apt to occur at different portions of an annealing oven. Such a state once existing, it remains practically constant, unless adequate means are provided for to equalize the irregularities. It is but natural that the charge itself is subject to entirely different conditions. There is usually an enormous mass of cold material heaped up in the interior of the oven that is packed in suitable boxes, which are arranged in several rows two or three high; and such a mass can not possibly be heated uniformly by ordinary methods. Such portions of the charge which are most exposed to the direct action of the hot gases must necessarily absorb a larger quantity of heat than others that are less exposed. The lower and central portion of the charge is least accessible to the action of the current of hot gases, the flow of which is usually directed from one side wall to the other of the oven. This is what retards the anneal and determines its duration. The heating of this portion of the charge is almost exclusively effected by the slow processes of conduction and radia-

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tion. The upper portions of the annealing boxes and their contents, however, are easily overheated should the firing exceed the admissible limit. These are conditions which can not be entirely avoided in ovens of large dimensions, but much may be done towards reducing the time of anneal by reconstructing the ovens, by changing the method of charging the ovens, and by accommodating the practice of annealing to suit these ends.

In reviewing the situation it must occur to one that the selection of the place where a pyrometer should be introduced into an annealing oven, in order to obtain by its aid the most serviceable information as to prevailing conditions, is of considerable importance. We have seen that at best no more should be expected from a good pyrometer applied under such conditions than a reliably correct indication of the temperature of a single part or section of an oven. It serves therefore as a trustworthy guide that at no time the temperature may be allowed to fall below or rise above specified limits at this particular place. The regulation of the fires must remain with the attendant. He is relieved from the responsibility of using his own judgment and from guessing at existing temperatures. The pyrometer galvanometer or indicator is his heat gauge, and the position of its pointer his guide which tells him when it is time to increase or decrease his fires, just as the pressure gauge on a boiler reminds the stoker or fireman of his duty.

A far more radical method to ascertain and to follow the changes of the thermal conditions of an annealing process is to measure the temperature of the material itself. This may be connected at first with some difficulties, but it is by no means impractical. It is certainly the true way of proceeding if one would obtain positive results which may serve as a suitable basis to lay down iron clad rules for the allowable maximum limitations of our heating process. The writer is not aware that this has ever been attempted in malleable iron practice, but he had the opportunity to assist in developing some methods after this principle for the annealing of sheet steel. The results proved to be very satisfactory, and, in fact it was found to be the only

reliable means to produce superior brands of electrical steel, which could not be obtained by other means.

In applying such methods to the annealing of malleable iron it would suggest itself that the temperatures of the hottest and the coldest portions of the charge be followed up regularly. And as we should be informed of the respective temperatures of the malleable iron castings themselves, our measurements should be taken at the interior of the annealing boxes. This can not be done unless a few—say two or three—boxes of each charge are specially fitted up for the purpose. The arrangement does not require anything elaborate. A suitable rigging would be an iron or steel tube half as long as the width of an annealing box, secured to its interior opposite a corresponding opening left in its side, of which it forms a continuation, extending inwardly like a thimble. The inner end of this tube must be closed, and the outer one may be provided with a flange which can be held in place against the inside wall of the annealing box by a wedge that fits between ribs, arranged for the purpose. The joint between box and flange of the thimble is luted with fire clay to prevent air and gases of combustion from entering. These test boxes are arranged in such a manner that the described thimble like tubes stand in alignment with observation holes left in the walls of the annealing oven. The thimbles themselves are arranged as nearly as possible in a horizontal position for all types of pyrometers excepting for those constructed after the radiation principle, when they should incline upwardly with their inner closed end, so that a line drawn from here through the observation hole of the furnace wall will fall with its outer end about five or six inches lower.

The rest is easy. Any suitable form of pyrometer is introduced with the necessary precaution into the interior of these boxes, or the telescope of a radiation pyrometer is focused to the bottom of the thimble, and the indications received will be the temperatures that prevail at these particular places, and not those of the furnace or of the surrounding furnace gases. It would seem that this or some similar method is the only correct way to ascertain the temperature of the castings themselves.

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The above dwells especially and specifically on the application of pyrometers in annealing practice, and apparently with good reason, as it is in this particular process where these instruments undoubtedly find the most extended use, and it is here where they should prove of the greatest value if properly applied. But aside from this there represent themselves many opportunities to make good use of them at other places in a malleable iron foundry. It is not the intention to enter here into the details of such varied applications, as each of these furnishes ample material for subsequent papers which can not be taken up at the present time. Suffice it to say that pyrometers can be also applied to excellent advantage for the regulation of melting furnaces, for the examination and most advantageous distribution of checker works in Open hearth or regenerator furnaces, for flues and stacks, for the melting and pouring of iron, as well as in core ovens and in the laboratory of the chemist.

It should require but little argument to convince the user that the same equipment or the same fittings of a pyrometer are rarely suitable for temperature measurements of metallurgical processes that are of different nature or which are conducted in furnaces of different construction or design. The variety of their applications, to which reference has been made in the foregoing, should present sufficient reasons why it is impossible to devise a single universal form that would prove equally convenient and equally serviceable under all conditions. And as the success to be derived from the use of these instruments depends largely upon their form, their fittings and their equipment, which must be specially adapted to the particular use for which they are intended, it is always advisable to leave the selection of the apparatus in the hands of a specialist in such matters.

There are many people who expect that after they have spent hundreds of dollars for a new wrinkle, of which they have heard that it served others to obtain the desired ends, their old troubles and difficulties should be overcome even before the package has been delivered. That is unreasonable. Physical instruments perform no magic. Chronic ills can not be cured in a day, intricate problems can not be solved without intent study and without

intelligent application of our faculties, results can not be obtained without effort, and a frail system can not be built up without patient nursing. There is no easystreet to success; it is strewn with many obstacles which prompt the timid to turn back, and which are surmountable only by a few selected ones, who are possessed of enduring strength and of indomitable will. Such men are ordained to become the true captains of our industries.

This is not mere phraseology, but it has direct reference to the application and care of pyrometers and other similar physical instruments which have found a way into our manufacturing establishments. They are of necessity mostly of a delicate nature, and their judicious handling and proper treatment must be learned before they can be mastered. It can not be expected that they should prove of immediate success in the hands of a novice, nor that their application should bring marvelous results the first day. They are a decided deviation from other tools and appliances used in our factories. This explains why the necessary skill of safely handling them is occasionally acquired at the expense of some unfortunate breakages, which, however, are caused almost without exception by overcarefulness and consequent awkwardness. Such minor difficulties, if they should happen, must not discourage the user. They will soon be overcome after the use of the apparatus has become common practice. The instruments are certainly no more delicate than a watch, or a glass tumbler or a china cup, and nobody will give it a thought of breaking them after they become as much used to them as they are to these.

A decided turn is reached after the first superior results have been obtained; after that there will be no going backward, no trusting to the good luck of the workingmen to run furnaces and ovens without them. That is the time when it will be acknowledged that the pyrometer has come to stay.

The introduction of these and other physical instruments into our manufacturing establishments is not a mere fad or fancy, or a whimsical trend of modern times which must be lived up to in order to keep up with the fashion. It is nothing of the

kind. It is a decided step forward, a means for the advancement of the arts, for the perfection of old methods, for improving the quality and enhancing the value of our products of manufacture, for predetermining results, for repeating previous successful metallurgical operations and thereby preventing failures and irreparable losses.

Let physical appliances be looked at in their true light, exclude all false misleading illumination, put them on the scale of a delicate balance in opposition to results, and their value will become more readily understood, their service will be appreciated. They will then be considered as absolute a necessity as the pressure gauge on the boiler, as the chronometer and the sextant on a seafaring vessel and as the time piece in our daily life. Their present extended applications have furnished many convincing proofs of their usefulness, and while today they are an acknowledged factor in the intelligent conductance of metallurgical operations, the period is rapidly approaching when they will be considered as indispensable in malleable foundries as the shovel and the rammer in the hands of the molder.

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American Foundrymen's Association

THE HEART OF THE FOUNDRY, AS SEEN BY THE FOUNDRY ENGINEER.

By D. S. Hawkins, Cleveland, O.

In all foundries, the well managed as well as the poorly administered, all departments and portions of the work seem to center at or radiate from the melting house, making it the heart of the foundry. The similarity permits going a step farther for what is really the life blood of the foundry comes from the cupola. The management may be thoroughly competent, the system may be perfect, the work of the core makers and molders may be all that could be desired, yet if the iron is not right as it comes from the cupola, the perfection in other departments goes for naught. Let us consider what distinguishes between the well arranged and the poorly arranged melting house, having in mind that substantially the same method of analysis can with profit, be applied to determine the efficiency and proportions of all the foundry departments. We will find that a vigorous application of common sense to the known working conditions is all that is required.

The problem of the cupola is an old one; we will not delve into its history, but will consider it as it is to-day, the result of many experiments and many failures. It is slightly more difficult of treatment than are some other scientific problems

because of the mystery which has surrounded chemistry and the melting furnace since the days of the alchemist.

Behind the veil of mystery, we see a shell lined with refractory material into which is charged fuel and iron. The iron must be melted. The fuel must be burned to supply the heat for melting the iron. Oxygen must be supplied to support combustion. The object is to melt the iron rapidly, to get it hot and to do so at the lowest cost. Having the main features before us, we will consider average cupolas. The iron must have coke under it. The depth of this bed varies more than it should The slag hole must be high enough above the sand for the bosh to contain more molten metal than the cupola will melt during the removing and setting of ladles toward the end of the heat when the ladles are handled less rapidly.

The tuyeres must be high enough above the slag hole to prevent slag overflowing into the air chamber. Above the tuyeres we must have enough coke to heat the walls of the cupola, to heat the blast and also to melt the metal. A considerable difference in the height of the tuyeres makes no appreciable difference in the heat of the metal, provided enough air is present.

Many calculations and catalog lists for cupola and blower capacity are based upon "30,000 cu. ft. per ton". Recently in England a reduction was recommended in this amount. These figures are based upon theoretical combustion with pure dry air, conditions which cannot be even closely approximated in the cleanest foundry. The foundry air contains a large per cent. of moisture, is low in oxygen and contains a large percentage of gases and dust which retard combustion. The assumed conditions also require a fuel ratio of 8 with 86 fixed carbon and make no allowance for the balance of the fuel nor the moisture which the fuel and air must contain. Another factor which is ignored is that after forty per cent. of the oxygen is consumed the air will no longer support combustion. Theoretical combustion with foundry air would require 35,000 cu. ft. per ton. Actual conditions raise the required amount to about 87,500 cu. ft. per ton in dry weather. During wet weather about twenty per cent. of the

fuel is consumed to evaporate the moisture in the air, and the effective fuel ratio is reduced to 6.7 requiring 105,000 cu. ft. per ton. A very large per cent. of the heat of combustion is carried beyond the melting zone. When there is not enough metal above the melting zone to absorb this heat it is wasted in a manner most uncomfortable to the men charging. With tuyeres too small for the cupola very little dioxide is formed below the charging door and the greater part of the heat is wasted.

The amount of air in the cupola depends upon the blast pressure and the size of the tuyeres. For purposes of economy the blast pressure should be as low as possible. It is expensive and unwise to use high pressure and small tuyeres. When the equipment is reasonably good the air pressure in the melting zone is the same as it is at the blower. Mellow blast is a misnomer and cannot be obtained with a high air pressure in the air chamber. Rapid combustion, and the resulting high degree of heat, is derived in porportion to the unbalanced pressure inside the cupola, provided the other factors are properly considered. The factors determining the required blast pressure are; the effective area of the cupola and the effective area of the tuyeres, the nature of the charge and the temperature required. The effective area of the tuyeres depends upon their shape and smoothness and the cell structure of the fuel. The effective area of the cupola depends upon its diameter, the ratio between the diameter and the distance from the tuyeres to the top of the charge, the method of charging and the cupola lining. The shape and location of the tuyeres are almost negligible for this portion of the cupola problem.

In constructing the tuyeres, we should seek to eliminate box forms which through unequal expansion always crack.

The opening in the tuyeres must be small enough to resist the tendency of coke to fall in.

Faster melting by the use of upper tuyeres indicates that the lower tuyeres are not large enough. When the tuyeres are large enough, the gas cannot be ignited at the charging door.

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One very common mistake is to make the cast iron portions used inside the cupola, too heavy. With a thin section the heat is radiated more rapidly and melting or cracking is prevented.

One type of tuyere on the market comes very near to filling the ideal conditions, but in the catalog no mention is made of its two chief advantages.

There are a few who consider that the central blast is better than the side blast, but the advantage which the central blast might have over the side blast terminates the moment the air is inside the cupola, providing both supply a sufficient volume of air. The central blast has the disadvantage of being troublesome to make up, and has a tendency to leak.

Fancy shapes and bevels for tuyeres are of no more importance than is the color which they might be painted. The blast must be distributed so as to have the largest possible melting zone, and the melting zone must be as near the bottom of the cupola as possible.

Upper tuyeres soon lose their shape and burn out. When the tuyeres quickly show the effect of the heat they are wrong, usually too small. The blast protects the tuyeres when they are anywhere near to the place where they should be.

Various proportions have been published for tuyere areal ranging from about one-tenth as large as they should be to three times as large as is required. A popular size has been from two to three times the area of the blower outlet; this is several times too large if the blower is of suitable capacity. Most blowers are very much over-rated.

The area of the tuyeres and the blast pressure must have a proper relation to the heighth from the melting zone to the charging door sill, regardless of the economy that would be obtained by having the tuyeres and blast correctly proportioned to the cupola. This fact has been overlooked in many cases to the disadvantage of the foundry. The tuyeres are nearly closed by coke and the ratio between the effective area of the

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tuyeres and the effective area of the cupola at the melting zone must approximate the increase in volume which the air has undergone during its rise in temperature. A considerable variation from the correct ratio does not show a marked difference in efficiency, but any variation from the correct size is at a loss.

The blast enters the tuyeres at atmospheric temperature, passes through incandescent coke and is very rapidly heated to the highest temperature which the metal will absorb. The distance traversed by the air in arriving at this temperature is practically the same under all working pressures. The location of the melting zone is substantially the same with a low pressure as with a high pressure blast. Bridging is made more liable by lack of air. A high blast pressure increases the area of the melting zone.

The air in passing up through the cupola follows the curve of least resistance, losing its heat and velocity and giving an egg shape to the melting zone. This shape varies for different methods of charging, some of which cause rapid cutting of the lining. This is particularly true when through a mistaken idea of confining or concentrating the blast, the cupola diameter has been reduced. This reduction in diameter does not increase the melting speed, unless something else is wrong with the cupola design. The charges of coke are reduced after the cupola has become heated and the melting zone is lowered slightly until the cupola gets up to full heat in about thirty to forty minutes after the blast is on. This condition a good melter can usually maintain throughout the balance of the heat.

The charging door sill is located from 6 to 20 feet above the bottom plate, a very convenient range, permitting the cupola to be anything between practically useless and very efficient.

When the distance between the melting zone and the charging door sill is right for low blast pressure, it is low enough to cause insufferable heat at the charging door, when higher blast pressure is used.

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A large part of the bad iron is caused by improper conditions on the charging floor. Where the space is too small for the men to handle materials rapidly in charging, and where the charging door is too near the melting zone the men make no pretense at proper charging. The mixing of the iron in charging, the vital point, is generally intrusted to those who know the least about it, only what they can remember of what they have been told. The pigs should be laid flat to the lining and never end on because the lining is less cut and the iron melts faster with a larger surface exposed.

The last charge should contain the scraps from the tumblers, so that the blast will not blow through too soon, and require slowing down the blast.

The charging door sill should never be high enough to require a short man to raise the iron with his arms. Six inches is a very desirable height.

Where a cupola even as small as 48 inches inside diameter, is melting to its full capacity, two charging doors are better than one, particularly when both fuel and metal are weighed. Both doors are used for rapid charging of coke and iron.

The charging door is frequently lined with refractory material making it heavy to manage and likely to burn out and crack in a short time. The correct form of charging door is one made of perforated sheet metal.

Charging machines are all right in special cases, but uniform distribution of the charges is not possible and the lining is destroyed more by the charging machines than by hand charging.

Frequently improvements or changes in cupola construction, excellent for special conditions, have been adopted for any and all conditions, whereas, the ideal for one case may be almost useless when governed by the working factors in another case. The ideal management for a cupola in a large foundry might easily be ruinous for a small foundry.

Some air chambers are made six inches wide with a sectional area three or four times the blower outlet. This keeps down the diameter of the cupola at its base, so that it can be placed in a confined corner where it should never be located, and the melter can be nearer to the cupola when he is tapping. The wind-box is practically cut in two at the slag hole, and at the breast. This reduction in section at two places makes it necessary to connect the blast pipes to the air chamber at two places. With the wind-box of the correct section, these conditions do not exist, and the blast pipe can be connected tangent to the air chamber as it should be.

Cupolas made without cleaning doors on the air chamber are wrong. Cleaning doors facilitate the removal of material which falls through the tuyeres. With several cleaning doors at convenient places safety tuyeres are not required. These doors are very useful for natural draft when burning up the bed. The iron and cupola are gradually heated up at a minimum expenditure of coke and lining. There should be holes in the air chamber opposite the tuyeres, covered with frames containing peep holes about 1 1-2 inches in diameter, these peep holes being covered with mica so that the inside of the cupola can be watched by the melter. The peep hole covers should be open when the blast is put on to provide an escape for the accumulation of gas in the blast pipe which otherwise is liable to explode.

The majority of cupolas are not provided with spark arresters because the right one is not yet designed. Until the correct design is discovered we shall continue to burn up foundries and destroy the foundry roof with an accumulation of cinders on the roof and in the gutters. Spark arresters are particularly desirable on cupolas contracted above the charging door because of the increased distance the sparks are thrown.

Methods for recuperation have been frequently attempted and patented. During this year another modification has been written up in the trade papers. There is small probability that recuperation will prove a success in fairly well conducted single cupolas where the heat is of only a few hours' duration. The only heat available at the time when it could do any good is

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radiated from the shell, and Colliau found the cost of saving this heat more than offset any possible gain. The heat above the charging door should be only a few degrees above atmospheric temperature in a good cupola.

Every cupola should be provided with a blast gauge to help the melter form a better estimate of the conditions existing in the cupola. A sufficiently correct blast gauge can be made by bending a glass tube in the usual U shape, partly filling it with mercury and marking it 16 ounces per inch. This gauge will be more reliable than most of the gauges now for sale.

The size of the cupola should be determined by the size of the average heat for the foundry. When this heat cannot be poured off in 1 1-2 to 2 hours it is done at a loss in molding time and over-head expense.

Foundries can seldom afford to be without at least one spare cupola. For a production of 500,000 lbs. per month it is usually best to let some other foundry make the castings, unless there is some special local advantage or slow delivery to contend with. A minimum equipment for this output would be one 36 inch and one 48 inch cupola. Some economy can be obtained when 1,000,000 lbs. are poured per month. A minimum equipment for such a foundry would be one 48 inch and one 54 inch cupola. The economy increases as the output increases and the minimum equipment for 1,500,000 lbs. output is one 48 inch, one 60 inch and one 54 inch. cupola. For a 2,000,000 lbs. output a minimum equipment would be one 48 inch, two 54 inch. and one 60 inch cupola.

There is still opportunity for study in cupola construction and there probably will be for years to come.

A majority of cupolas are now operating under economic conditions which would not be permitted in any well organized machine shop.

Too little engineering supervision is given in most foundries, and the losses in nearly every case would more than pay for frequent inspections.

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Foundry engineering is the science of economical production in the foundry, a highly specialized branch of engineering, although its scope covers nearly the entire field of industry. Its aim is to make the foundry more productive. The specialization in engineering, in law and in medicine have all been comparatively recent necessities. As in both law and medicine there are conditions and means with which to meet the conditions after a specialist has diagnosed the troubles, some one else can apply the cure. The foundry engineer cannot accomplish the impossible but, by applying the principles of economical administration and production, can in many cases come very near to working miracles.

By mingling with a large number of aggressive and intel ligent foundry men all of whom in their own way are striving for higher efficiency, the foundry engineer is continually in posi tion to show each client where economics can replace the methods in vogue both in administration and buying or selling. He can often dispell the mystery which surrounds the heart of the foundry and other departments, even when the managements believe it can account for every dollar going into the work and that not a cent is wasted.

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American Foundrymen's Association

DISCUSSION ON FOUNDRY COSTS.*

1. *Question*—Mr. Franklin has stated that the system which he has outlined is clerically economical to operate. Just what does he mean by "clerically economical?"

   Mr. Franklin.—In stating that this system is clerically economical, I mean that in most foundries melting say 40,000—60,000 pounds per day, this system can be operated by a $12 or $15 a week clerk. It is now operating in four foundries, one of which melts an average of 450,000 pounds per week, with only that amount of clerical labor.

2. *Question*—Can Mr. Franklin give us any specific cases where his system is operating, and some idea as to the clerical force required?

   Mr. Franklin—I have mentioned that this method is now operating in four foundries. I dislike to mention these publicly, but to anyone interested I should be very pleased to give the names of these companies privately.

3. *Question*—How have the methods outlined enabled the foundries where they have been installed to increase their profits?

   Mr. Franklin—That question requires for full satisfaction rather a long answer, and the paper is an intent to give this

*Communicated by Mr. B. A. Franklin, as the result of numerous inquiries received since the Convention.

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answer. To repeat briefly, however, this system first gives, not the average cost, but the discriminating, particular and proved cost of each separate pattern or order of castings; and thus forms an exact basis for getting a profit on each order or giving the definite knowledge of a loss, if one is made, and so offers the foundryman a right basis of selling. This has always proven a profit making knowledge.

But more than that, a little study of the system will show that it offers a basis of reduction along the main elements, such as increase of per cent. of good castings, decrease of per cent. of bad castings, reduction of the different elements of expense, as fuel, melting, moulding, cleaning and general expense; because it shows constantly, by comparisons and by its detail, the leaks and weaknesses which compel efforts to remedy.

As a matter of fact in three foundries where this system is working, the fuel expense per pound of melted metal and the non-productive labor and supply cost have been materially reduced; and in all four cases, many cases of individual orders have been shown, where a profit was thought to have been made, but really a loss was made; and almost invariably larger prices have been obtainable.

Also, some cases have been discovered where the profit was larger than supposed, and where the knowledge of true cost has permitted the satisfactory retaining of the work when competition became difficult.

4. *Question*—Were they running successfully before you took up their work?

Mr. Franklin—The plants were running successfully before we took up the work, but are more successfully run now, because of the definite knowledge and control the system gives.

5. *Question*—How will a cost system such as Mr. Franklin outlines enable us to get more for our castings?

Mr. Franklin—Such a system will not always enable a foundry to get more for its castings; but it will bring about an effort

to do so where a loss is being made, and this effort is very frequently successful, especially when the customer is frankly shown the costs and realizes that in the long run he must buy his castings at a price which permits the foundry a profit. It also shows what work the foundry can do successfully, and what it cannot successfully compete on.

6. *Question*—How will it enable me to get any more work out of my molders?

Mr. Franklin—It will enable a foundry to get more out of the moulders by showing up those cases where the moulding labor is excessive, and thus bringing about a criticism which the human nature of the moulder—when he knows he is watched—compels him to respect by speeding up.

7. *Question*—How will it enable me to reduce my expenses?

Mr. Franklin—It will bring about a reduction of expense by showing the detail of these expenses weekly in comparison and their relation to the weekly production and progress, and thus show leaks and weaknesses.

8. *Question*—Do you advise keeping detail cost on each individual casting?

Mr. Franklin—This, of course, is a matter of individual judgment. In cases of constant duplication, I should say it would be entirely unnecessary, except at definite periods. In many cases, where the work of one concern is taken at a given price, it seems sufficient to know merely the weekly or monthly cost of all castings lumped together which are shipped to this one concern. This is unquestionably a matter for particular judgment and common sense, and development will show how far it is desirable to go in this direction.

9. *Question*—Would it not be as satisfactory to classify castings and obtain the finished cost by classification?

Mr. Franklin—If by classification is meant bench—floor—machine, I should say it is absolutely essential to make such

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classification. If by classification is meant that of weights, I should say such a method would not give true costs, as every foundryman knows that two castings, each weighing 100 pounds, may cost entirely differently.

I am glad such practical questions have been asked, because the system has met just these questions in actual operation.

American Foundrymen's Association

DISCUSSION ON CONTINUOUS MELTING.*

By Geo. K. Hooper, M. E., New York City.

I am very glad to be able to discuss the subject of Continuous Melting, as it is one in which I am deeply interested and one with which in my experience of the last ten years in designing and building foundries, I have been intimately connected. My first piece of work in fact as an engineer was the development of a very complete continuous Foundry system and I have since designed several others and been connected with other foundries containing systems more or less continuous and am at present building for a well known interest a very large malleable foundry embodying quite a complete system of mechanical handling, it being impossible in this case, of course, to carry on continuous pouring although the melting proper goes on practically all day.

Out of this experience I am enabled to enlarge somewhat upon the answers to questions asked Mr. Sleeth, for instance, that of, "on how small a tonnage can continuous melting be made to pay." He answered that this depends upon the work in any particular foundry upon which I would enlarge by saying

*A discussion on Mr. Sleeth's paper presented at the Cincinnati, Convention, May 1909.

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that the tonnage has less influence on the economies to be gained by operating continuously than the number of molds to be handled, as it is at once apparent that a few molds may contain a large tonnage to which continuous methods would be entirely unsuited, while a less tonnage frequently is distributed in a very large number of flasks, the handling of which, with the sand, castings, cores, etc., would undoubtedly yield large economies if carried on mechanically and continuously. The mold, therefore, is the unit which must be used when considering whether the continuous method can be applied to any particular production, but it is not necessary to feel that if many sizes of molds are used, the system is inapplicable since, as the sand is handled mechanically, it may be a considerable saving to standardize flasks to a few sizes and adapt the patterns to these standardized flasks thus enabling a larger range of work to be handled with a minimum of difference in equipment in flasks, machines, etc.

Again Mr. Sleeth was asked if the hot sand has any effect in causing loss of castings his answer very truly being that generally it has no such effect if the pattern plate be suitably warmed. He spoke of a twenty-minute period as the time in which his sand is in circuit. I am able to enlarge upon this by saying that by means of large cooling and mixing riddles it is possible to considerably shorten this time and consequently the amount of sand handled and I am familiar with systems where the sand is actually in use again in a much shorter time than this, the first system with which I had to do having the sand in transit less than three minutes from the time when it was dumped out hot, riddled, cooled, tempered, mixed and again deposited in the hoppers over the machines for reuse going again into the mold undoubtedly within another three minutes.

Since the proof of the pudding lies in the eating, I am able to say that the foundry loss in this system was much less than when the molds were made on the floor, and this is, I find, the general experience of all who have these continuous systems, viz.: that they operate with less foundry loss than the same work when made on the floor even though a lower rate is paid for labor in operating such system than is customarily paid in floor work.

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It is proper at this point to speak of methods of handling molding sand by means of conveyors, and I will say of this that in my experience, belts are the most suitable for this purpose. Canvas belts can be efficiently used where the sand is dry as in shaking out or dumping conveyors, but with tempered sand a rubber belt is preferable as the sand will more freely discharge from it, and the moisture of the sand will have less effect on the belt's surface. Flat belts are superior to troughed belts for this service and wide belts moving slowly than narrow fast running belts.

A drag or scraper conveyor may be used in distributing sand to hoppers over molding machines, and is in fact the best device for this service and it also should be large and slow moving, both to avoid wear and to preserve the condition of the sand since the tempered molding sand has a tendency to "ball," and once in that condition must be crushed or dried to again render it suitable for use. The drag conveyor is preferably made with a wooden trough and wood conveyor flights.

Netting on riddles and sieves is preferably made of phospha bronze wire. Tap bolts and nuts on apparatus requiring renewals should also be of bronze.

A type of "continuous foundry" has attracted considerable attention the past few years in which the molding and pouring is done on one floor, the shaken out sand falling through gratings into a basement where it is suitably prepared and sent again by elevators to the floor above for reuse. I have failed to discover any advantage in a foundry constructed in this way and it possesses in fact the very serious disadvantages of high cost of installation and operation since a two story building costs at least three times as much as a one story building—probably the difference is greater than this where a floor is filled with gratings and supports for machinery, a large expense is involved in duplication of equipment for screening and retempering sand, and more labor than is necessary is employed in this latter work.

It is entirely possible to handle all of the sand required by productions up to 100 tons of castings per day and over with two

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men although as much as 100 tons of sand per hour may be passing through the systems.

The users of a very successful system handling a large tonnage have informed me that they use no men at all on their sand handling system, but it is difficult for me to believe that it is not given some attention during the day. I believe though that two inexpensive men can handle the largest sand conveying system.

Such two story foundries are therefore in my opinion and experience much more expensive to build and operate than modern practice makes necessary.

Mr. Sleeth was further asked if any damage is noted to molds from the movement of the mold conveyor to which he suitably responded that none is noticed. This would in fact be predicated by the fact that the foundry loss in these systems is generally less than in floor work, but I can go a step farther than this and say that molds may be subjected to what would be considered very rough treatment and yet suffer no damage as I have repeatedly loosened up all connections on a mold conveyor and shaken the car conveying a mold with all my strength while it was being poured, banging the carriage against its supports hard enough to slop the iron out of the sprue and found no apparent defect by sufficient commercial test in the casting.

The casting made in these molds was a hollow casting of varying lengths and thin section poured from one end, the core held by a pivot at one end only, resting upon wire chaplets bearing against tin "spots" in the core for the remainder of its length.

I am familiar with mold conveyors in which the carriage is suspended from an overhead track and allowed to swing free except at the point where the pouring is done and no trouble is experienced by damage to the molds. A gain is in fact made by building a mold conveyor in this way as less power is required for driving it, less wear is entailed, and the supporting frame work is cheapened.

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I have learned of a continuous foundry in which the molds when made are carried to the cupola upon trucks provided with springs, poured and then carried on to a cooling and dumping point and I am advised that the loss in this foundry is less than it was when the same molds were poured upon the floor by bringing the iron to them.

The operation of the cupola was also touched upon. My experience goes to show that this is perhaps the most easily managed function of the whole system since, if the blower—and I think the positive blast blower is best for the purpose—be driven by a direct connected engine with its valve easily accessible from the pouring platform, great variations in melting speed may be obtained with little detriment to the quality of the iron, and by thus handling the blower and having means of communicating at the same time with the charging floor, the cupola may be easily held for considerable periods, such as for changing patterns etc., etc., and operation started immediately when desired. I have spoken of stopping for changing patterns on purpose, as there is little need for extended stops on any other account, as a suitably designed system will operate on less than 2 per cent. loss of running time from accidents.

The cupola is preferably run with an eye to the production of castings rather than the saving of coke but this, of course, settles itself and a ratio develops itself which may easily be as high as the best cupola practice affords. Mr. Sleeth has told you in fact that his is between 10 and 11 to one. It is much better, though to produce castings than try to save coke.

I am a little surprised to find among foundrymen, otherwise so well informed, an impression that this continuous method is in an experimental stage. Nothing could be farther from the fact as the method is so aged that the "Mother" patents upon it have expired and the former owner of them, who is here, has just told me that his original system has been running for eighteen years and is still in use. I had the privilege of building quite a complete plant some six years ago for his company, in which three systems were installed, one entirely continuous and two intermittent, that is, in one the molds are carried, and in the

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others, only the sand is handled by conveyors, the molds being poured on the floor from iron brought on overhead tracks and these systems have been in continuous operation. His company is now building a foundry containing four continuous systems. My own experience with this method began ten years ago with a system which was put into successful operation.

Mr. Sleeth's has been running for undoubtedly fifteen years, perhaps longer. I am familiar with it for about twelve years, and there are a sufficient number of others in successful and every day operation to put the scheme entirely out of the class of experiment.

There have, of course, been some attempts which have been notable failures, several systems having been devised and installed by builders of conveying machinery who have attempted to handle molding sand as they would other and very different materials and who have not had a sufficiently adequate comprehension of the comparative relations of the foundry operations involved and on the other hand, many capable foundry men have designed systems which they have tried to make too automatic. I can recall one generally on the lines of Mr. Custer's design, but which failed through not having his permanent mold.

He has put the continuous method very far forward and is entitled to great credit for his success.

Elasticity is very essential in every function in the continuous method with the sand mold and plenty of "elbow room" where the different operations are brought together.

Finally then it appears to be demonstrated by the considerable number of successful systems in use that by means of mechanical handling systems in the foundry the efficiency of the workman is increased from 10 to 50 per cent. (this increase having been duly charged, with what additional non-productive labor is necessary), the average wage can often be reduced somewhat, the foundry loss is decreased, the floor space reduced sometimes by as much as one-half, this also taking account of necessary additional power plant, etc., and by mechanical hand-

ling only, can the full capacity of molding machinery be realized.

The increase in capacity available from molding machinery is considerable, even though sand handling machinery only be employed, as in some classes of work, sand handling machinery only is possible, malleable work for instance, in which the melting is done in the air furnace. while investment charges are not seriously increased when the saving in equipment due to increased efficiency is considered.

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American Foundrymen's Association.

MODERN METHODS AND THE BUSINESS SPECIALIST.*

A New Development of Business Practice.

By Ellsworth M. Taylor, New York.

In the presentation and discussion of the papers at the recent convention in Cincinnati of the American Foundrymen's Association, one point stood out with prominence which was extremely gratifying to those who are interested in observing the progress of scientific and systematic methods in foundry practice and in the practical conduct of manufacturing undertakings generally. It made no difference whether the subject before the meeting was "The Cost of Steel Melting in Foundries," "Continuous Melting," or "The Permanent Mold," here was always present in the discussion an earnest desire to bring out the facts based on systematic, scientific research.

Take for example the questions asked of Dr. Stoughton after the interesting comparative figures had been shown of "The Cost of Steel Melting in Foundries." Again, to be more spe-

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cific,"Do the costs shown cover all the costs which are incurred up to the ladle?" And again, to be more specific, "Do the casts shown cover all such items as administrative cost, taxes, insurance, depreciation, etc., as well as the usual repairs?" And if one closely studied the faces of the splendid body of men present in the room, he failed to note a single expression of surprise that such a question should have been asked. On the contrary, a quick glance at the faces nearest showed a general acquiescence in and understanding of the question and an acceptance of the raising of the issue as being good and proper.

What a different reception such a question would have been likely to have received if asked in open meeting a few years back! But the great body of men engaged in the foundry business have been undergoing a course of scientific business education in the past few years, largely under the auspices of the American Foundrymen's Association and allied associations. These men have come to realize that they must not only melt scientifically, handle their material scientifically, but they must operate their properties on up-to-date, scientific business principles. They must not only be systematic but scientifically systematic, in order to hold their own and to bring foundry practice up to its highest and most economical efficiency.

Just stop to consider the effect of the question, "Did you include the items of taxes, depreciation, insurance, etc., in your comparative figures?" on the minds of the men present. Here we have a gathering of sound, practical men who for several years past have had their attention directed to the fact that there is such a thing as a scientific cost of their products, and who although they may not have installed the scientific method have come to recognize its existence. Suddenly one of their number asks the question I have quoted, or says, when taking up the matter of continuous melting, "At what point do you consider the continuous melting system to be economically inefficient?" Or, "What tonnage is it necessary to melt each day in order to make the continuous melting system profitable?"

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These questions bring right up before every man who hears them the vital problem of scientific business methods and costs. Who can answer such questions accurately and authoritatively? The manufacturer who operates his business on a basis of scientific costs. No one else can answer. And when figures are given and a man stands up and questions the items which go to make up the figures, his neighbor, who has only until then tacitly acquiesced in scientific methods, suddenly begins to see the light and silently makes compact with himself to go deeper into the subject of scientific costs. So another step has been taken in the right direction.

But how is the man who has had no special training in scientific business or costs methods to introduce them in his business? There are three possible ways:

1. He may do it himself without any assistance except what he may get from reading books and magazine articles on the subject.

2. He may do it himself under the general guidance and with the professional assistance of the man who has made a specialty of business organization and scientific methods and system.

3. He may place his organization entirely in the hands of the specialist, allowing the latter to come into his business, actually take up the reins and operate the property from day to day until after all the changes have been instituted—the owner of the property taking a back seat in the meantime.

Of these three methods which is the most economical? The second undoubtedly, and in the vast majority of cases that method should be followed.

The first method—"the go-it-alone" idea—is not the best, for the same reason that it is not advisable for the average foundryman to act as his own chemist without undergoing a

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course in chemistry. Some few men may be able, if they have no other matters requiring constant attention, to take up some books on chemistry and work out for themselves an analysis of all their irons, etc. But how much more quickly, thoroughly and satisfactorily such a man would get his results if he had the guidance and help of the practical and experienced chemist who had met with and mastered basic principles, and could direct his attention unerringly to the correct methods for the solution of the chemical problems which are peculiar to his needs and requirements.

For these reasons the foundry chemist finally has come into his own. There was first the gradual conviction on the part of the foundry owner or manager that the knowledge of the chemist was a valuable aid in the solution of some of the difficulties he was continually trying to overcome. As is the case in all lines of industry when a reform is instituted, considerable chaffing had to be endured by those pioneers who foresaw the value of scientific chemistry as applied to foundry production. The smile of incredulity, however, finally gave place to a sober realization that there was something in it, and then began the rush to get aboard the chemistry band wagon. The foundryman concluded he had enough on his hands without attempting to be his own chemist, and he made arrangements with the specialist either to give him professional consultation at stated periods or to render him service by the year.

This is just a little story of evolution, and in relating it I am leading up to the real purpose of this article, which is to call attention again to the evolution of that latest of modern specialists, the exponent of scientific business methods of properly regulated systems, of production costs, organization and accounting.

Like the foundry chemist, this new specialist is the growth of modern business necessity. He was the first to realize the necessity for his work to be synthetic as well as analytic, and to see the peculiar advantages which he possessed by reason of his

diversified experience and intimate contact with the details of every character of business. The business world was slow to receive him at first. He met with many a rebuff, but he has surely overcome the prejudice against his employment in this capacity, and the services he renders in it are recognized as valuable and necessary, particularly to manufacturing industries, and equally legitimate with those rendered in his earlier and more widely known capacity.

His field for usefulness is so broad and he is required to have such an intimate knowledge of all business affairs in general that unfortunately, while he is rapidly becoming recognized as a professional specialist, no attempts have been made to apply some special and definite name to describe this branch of his profession.

This phase of the situation is further complicated by the desire on the part of individuals and companies engaged in systematizing work alone to adopt a name which will be distinctive and which will appeal to the business world as being a thing by itself, and which may be advertised as something obtainable nowhere else. Perhaps this may have been one of the things which has made the business world withhold its stamp of approval of the work as professional.

Be that as it may, we find men engaged in the work variously classified as "production engineers," "industrial engineers," "business engineers," "systematizers," "specialists in factory organization," "costs experts," "special service experts," "chartered accountants," "public accountants," "certified public accountants," "accountants" (in the broadest sense, of course), and there are numerous other classifications with which the business world is more or less familiar. The scope of the work is so broad that any of these descriptions may be applied to it, and still there is something left to be said. But however these men may be classed, like the chemist, they are here to stay, and there is a steady and increasing demand for their services.

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They are required to have, first of all, an intimate knowledge of general shop practice; a broad experience, which means direct contact with many different lines of business and manufacturing; a general knowledge of certain branches of corporation law, commercial law and contracts; an intimate knowledge of the duties of all the executives and heads of departments in the business; a thorough understanding of the science of bookkeeping; an accurate knowedge of the principles and theory of accounts; a knowledge of men, and together with all these things, and above everything else, the professional man's power of concentration and ability to get at the meat of the matter under consideration quickly, and to separate instinctively the essential from the non-essential.

The special knowledge and information which these professional men have of all these subjects create the demand for their services, as there is scarcely a manufacturer in the country who at some time or other has not felt the need of advice along these lines, and the manufacturer is learning that it is to his advantage to consult these men professionally rather than to take the time which would be required to make himself able to arrive at a prompt solution of all the difficulties which he encounters.

It is probably true that in the past too much mystery has been thrown round the work which these professional men accomplish, and the business world has been led to believe that everything they have done is in the nature of a "miracle." This veil of mystery, however, is being rapidly dissipated and the "miracles" have been shown to be due to nothing more or less than a combination of natural qualifications, comprising experience, the scientific application of facts to actual conditions, scientific common sense and a reasonable amount of executive ability. And now that business men recognize the situation they are coming more and more to a realization of the advantages to be gained by using the fund of knowledge, information and experience which these professional men possess.

The result is that if the manufacturer to-day feels that he is not operating his business on sufficiently scientific lines, and

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if he wishes, perhaps, some information in regard to scientific cost methods, he finds that he may consult a specialist professionally at a fee arranged for on the hourly basis, the daily basis, the contract price for the entire work, or an annual retaining fee. In the large majority of cases the business man should be able to get all the assistance he requires by engaging for professional consultation on the daily basis. In this way the specialist will make a personal examination of the points which are causing trouble and will outline definitely the method for overcoming the difficulties. He will then instruct the employees in the share of the work which they are to accomplish, and will exercise only a general supervision over the work until the changes are thoroughly understood.

In other words, in the great majority of cases the business man should be able to secure that class of professional consultation which, acting in an advisory capacity, helps him over his difficulties and does not require to go into a concern and stay there continuously for weeks and months, doing the work which should be done by the employees themselves and which it is the business of the specialist to instruct them in and to see that they accomplish.

There is a growing demand for a class of professional business specialists (if they may be described in this way) who are trained and skilled in all the subjects which have reduced business methods to a science and to whom business men and manufacturers may go for consultation and assistance in mastering any specific points or conditions in his business which are giving trouble, and who may also be called upon to participate actively in the executive management of a business for extended periods of time, if such action is necessary.

If there is a doubt as to the need for the class of service which it has been endeavored to describe, it will be removed by an observation of the general trend of conversation between business men who happen to be traveling in the club or cafe cars of the railroad trains, and who casually enter into friendly conversation. In many instances the conversation will lead up

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naturally to a discussion of the merits of some new business method or system with which the men may have come in contact.

If this is not sufficient evidence to convince, attend some convention, such as that of the American Foundrymen's Association, and note some of the conversations which the men attending the convention will have with the man who is known to be devoting his entire time and attention professionally to the solution of business problems.

For example, the general superintendent of a fairly large manufacturing property employing over 1000 men recently told the writer of the improved conditions which he had been able to secure in his business by such a fundamentally simple matter as an up-to-date system for handling the thousands of patterns required in his business.

Another practical foundryman volunteered the information that he was a firm believer in scientific business methods, and that he would always insist on the installation of a proper system for keeping track of, and handling all materials in, any foundry with which he might be connected. This man went on to say further that he was convinced that a method of this kind was the only way to handle materials economically, and that he had first adopted such methods when he had undertaken to operate a foundry on a contract basis for the management. He stated that he was confident he had been paid many times over for the additional trouble he had taken to install such a system when he operated the foundry on the contract basis. In this case all the expenditure for the installation of the system and the cost of maintaining it came out of the pocket of the foundryman, so that his judgment of the importance of the system to him must be considered of value.

Another man of large business experience who some ten years ago was identified with a prominent manufacturing concern, where he had general charge of the costs system and

scheme of organization, but who has been too busy acting in an executive capacity for several corporations for the past few years to give much attention to the details of these two departments, made the statement of his own accord after he had received some consultation and had had a method of up-to-date scientific costs briefly outlined for him that he had failed to realize, until he had received the professional consultation, what a great advance had been made in operating manufacturing properties on scientific business and cost lines, and that methods which had been followed some years ago were absolutely inadequate to meet the requirements of to-day.

This is an instance where an executive has been so busy pushing the general policy of the business with which he is connected and keeping pace with the improvements in mechanical appliances that he has been out of touch with the great improvements in scientific methods of business organization.

There are a great many men who are owners or managers of manufacturing properties who are in the same position, and this class of men will appreciate more and more the opportunity for occasional consultation with professional business specialists. But they will want this professional information dealt out to them in a sane and safe manner.

If they are experiencing trouble in one or two directions they will not wish to be told that in order to straighten the matter out it will be necessary to put half a dozen representatives of the specialist in the business and keep them there for weeks and months at a time, incurring an expenditure of probably several thousand dollars. The instances where any such action is necessary on the part of a specialist are very few and far between. The class of professional service which the business man demands to-day and will continue to demand more and more in the future, is direct contact with the specialist himself, and simple and direct solutions of the difficulties which present themselves, so that with a reasonable amount of supervision on

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the part of the specialist the reforms may be instituted by the owners of the business with the assistance of their own clerical force.

When seeking professional services the business man should remember that he is not buying materials or merchandise. He is buying information and experience; consequently it is necessary, if he is to receive the best he can find, for him to depart a little bit from the regular traditions of the purchasing agent. He should realize that there is a difference in the quality of services which may be rendered, and that it is hard to apply the ordinary rules of buying in arranging for the services. If he is able to arrange for this professional consultation on the hourly or daily basis, reserving the privilege of terminating the service at his discretion, he certainly does not run any great risk of being involved in unlimited expenditure and may rest assured that the specialist is working absolutely on his merits and with the confidence, born of experience, that he will be able to solve the business man's troubles in a reasonable time and with entire satisfaction. This is the class of service which appeals to business men and which it is possible for the business man to obtain today.

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THE COST OF STEEL MAKING IN FOUNDRIES.

By Bradley Stoughton, New York City.

The object of this study is not particularly to publish the cost of making steel for castings, but rather to consider this subject from the standpoint of the future relation of electric steel-making processes to the present steel-making processes in foundry work. The electric process has already established itself in steel works for making ingots, especially in Europe where it is now a real factor in the industry. In America there are already some electric steel-making furnaces in operation, and several others in the process of installation, although none of these, so far as we are informed, will enter the steel casting field notwithstanding that there are indications of a lively interest in this type of furnace on the part of the steel casting industry. In introducing these figures, the writer would say that he has no connection with electric furnaces in any way and does not expect to have, the object in making the study being merely one of interest.

Acid Open Hearth.

The cost of steel making by the acid open hearth process is shown in Table I. In connection with this and the other tables it is to be observed that the price of raw materials is figured on

the basis of a ton, of 2000 pounds, and all prices in this paper are based on the current price of the materials in Pittsburg during the first week of May, 1909.

Table I.

ACID OPEN HEARTH.

Raw Materials.	Price of raw materials per 2,000 pounds.	Per 2,000 pounds of steel in ladle. Weight used, pounds.	Per cent. used.	Cost.	Cost.
Pig iron	$14.00	300	15	$ 2.10	
Heads, Gates, etc.	14.00	660	33	4.62	
Foreign scrap	14.50	1080	54	7.83	
Defective castings (3) account bad metal	50.00	20	1	.50	
Ferro-Alloys	40.60	29	1	.59	
Total metal		2089	104	$15.64	$15.64
Operating costs				(4)5.50	(4)8.85
Cost of steel in ladle				$21.14	$24.49
Cost of Steel in Castings.					
Cost of steel in ladle+65 per cent. (5)=				$32.52	$37.68
Less credit for heads, etc. as scrap=				4.62	4.62
Net cost of steel in castings				$27.90	$33.06

(3) The price given for defective castings is over and above their value as scrap. See the text following for further discussion of this charge.

(4) The charge of $5.50 for operating costs is the figure for a 25-ton furnace and large tonnage; that of $8.85 is for a small furnace and small production.

(5) Of the steel in the ladle, 65 per cent. goes into castings, 33 per cent. goes into heads, gates, etc. 2 per cent. is lost in spattering, etc.

It is not to be supposed that these figures will be accepted by everyone as representative of their practice or anything like it, but the prices and weights of raw materials can be changed by anyone to conform with his practice. Especially the item of "Heads, Gates, etc." will depend largely upon the class of work made. No doubt there are some foundries in which the percentage of heads, gates, skulls, scrap, etc. is less than 33, while in

others it will be above that figure. One has only to consider the difference in this respect between a foundry making steel rolls and one doing electrical work,—notably castings for motors,—to appreciate how great a difference will exist. I have adopted here 33 per cent. of scrap in the case of all processes to make this item comparative.

Table II.

BASIC OPEN HEARTH.

	Per 2,000 pounds of steel in ladle.				
Raw materials.	Price of raw materials per 2,000 pounds.	Weight used, pounds.	Per cent. used.	Cost.	Cost.
Pig iron	$12.75	1040	52	$6.63	
Heads, gates, etc.	14.00	660	33	4.62	
Foreign scrap	11.15	350	17½	1.95	
Defective castings (6)	50.00	40	2	1.00	
Ferro-alloys	40.60	33	1½	.67	
Total metal		2123	106	$14.87	$14.87
Operating costs				(7)6.10	(7)9.55
Cost of steel in ladle				$20.97	$24.42
Cost of steel in castings.					
Cost of steel in ladle÷65 per cent. (8)=				$32.26	$37.57
Less credit for heads, etc. as scrap=				4.62	4.62
Net cost of steel in castings				$27.64	$32.95

(6) See footnote under the Acid Open Hearth, Table I.

(7) See footnote under the Acid Open Hearth, Table I.

(8) Of the steel in the ladle, 65 per cent. goes into castings, 33 per cent. goes into heads, gates, etc., 2 per cent. is lost in spattering in pouring.

The item "defective castings" chargeable against the furnace, as distinguished from those chargeable against bad molding, will also vary greatly in different places and it is probably impossible to estimate an average figure, either for the precentage of these made or for the price. The latter will depend partly on the average selling-price of the castings, and partly on the condition of the castings when the defects were discovered;

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as for example, whether costs of cutting off heads and gates, cleaning, shipping to and from the customer, etc. should be included. In point of fact it is probable that there are not many foundries in which the defective castings chargeable against bad metal are differentiated from those chargeable against bad molding, yet it is evident that the former only should be included in the cost of steel. Defective castings chargeable against molding are included here in the item of heads, gates, etc.

Table III.

ACID OPEN HEARTH AND BASIC OPEN HEARTH.
[WHEN TOGETHER IN ONE PLANT.]

	Acid open hearth Per 2,000 pounds of steel in ladle.				Basic open hearth Per 2,000 pounds of steel in ladle.			
Raw materials.	Price of raw materials per 2,000 pounds.	Weight used, pounds.	Per cent. used.	Cost.	Price of raw materials.	Weight used, pounds.	Per cent. used.	Cost.
Pig iron	$14.00	300	15	$ 2.10	$12.75	1040	52	$ 6.63
Heads, gates, etc. from both furnaces	14.00	1320	66	9.24	.....	....	...	.....
Foreign scrap	14.50	420	21	3.05	11.15	1010	15½	5.63
Defective castings	50.00	20	1	.50	50.00	40	2	1.00
Ferro-alloys	40.60	29	1	.59	40.60	33	1½	.67
Total metal		2089	104	$15.48		2123	106	$13.93
Operating costs				5.50				6.10
Cost of steel in ladle				$20.98				$20.03
Cost of steel in Castings.					**Cost of Steel in Castings.**			
Cost of steel in ladle+65 per cent				$32.28				$30.81
Less credit for heads, etc., as scrap				4.62				4.62
Net cost of steel in castings				$27.66				$26.19

The charge of $5.50 for operating costs per ton, is practised with a 25-ton furnace operating at maximum capacity and charging raw materials by hand. For small furnaces, and furnaces operating at low capacity, this item will be materially larger. It is not to be supposed that the $5.50 is a minimum figure, as no doubt some practice is better than this, and $8.85 is not a maximum figure as the cost of some furnaces is somewhat higher.

Basic Open Hearth.

The cost of making steel for castings by the basic open hearth process is shown in Table II, and the same comments made under the head of acid open hearth steel will apply here.

Table IV.
CONVERTER.

Raw materials.	Price of raw materials per 2,000 pounds.	Weight used, pounds.	Per cent. used.	Per 2,000 pounds of steel in ladle. Cost.	Cost.
Pig iron	$14.00	300	15	$ 2.10	
Pig iron	17.40	1280	64	11.14	
Heads, gates, etc.	14.00	660	33	4.62	
Defective castings account bad metal	80.00(9)	20	1(10)	.80(10)	
Ferro-alloys	40.60	35	2	.71	
Total metal		2295	115	$19.37	$19.37
Operating costs				3.50(11)	5.50(11)
Cost of steel in ladle				$22.87	$24.87
Cost of steel in castings.					
Cost of steel in ladle+65 per cent				$35.18	$38.26
Less credit for heads, etc., as scrap				4.62	4.62
Net cost of steel in castings				$30.56	$33.64

(9)See footnote under acid open hearth table.

(10)The percentage of defective castings in converter practice will actually be less than this, so that the cost is a little higher than justice to average converter practice demands. In the absence of average figures, we have charged it the same as acid open hearth, with this correction.

(11)Operating Cost. $3.50 is for one 2-ton converter making 150 tons per week. The $5.50 per ton is a 2-ton converter with small production.

The difference in costs between basic and acid open hearth shown here is less than the experience of several would lead them to believe. The explanation of this is that the basic open hearth process is in use generally in districts where low phosphorous raw materials sell at a lower price as compared with high phosphorous raw materials than is the case in the Pittsburg district, and also because the greater proportion of defective castings made in the basic process is not ordinarily included in figuring

the cost of the steel. Furthermore, in the cost here given the basic process is under a disadvantage through having to use 33 per cent. of its own heads and gates which command a higher price in the market than scrap suitable for the basic process would demand. This condition explains the common practice of operating both a basic and acid furnace in the same plant, enabling the acid furnace to use the scrap from both processes at a favorable figure and thus allowing a larger proportion of cheaper basic scrap to be purchased outside. This condition is exemplified in Table III, where the benefit of the combination to both processes is shown.

Table V.
CONVERTER. WITH LARGE WASTE.

	Per 2,000 pounds of steel in ladle.				
Raw materials.	Price of raw materials per 2,000 pounds.	Weight used, pounds.	Per cent. used.	Cost	Cost.
Pig iron	$14.00	300	15	$ 2.10	
Pig iron	17.40	1360	68	11.83	
Heads, gates, etc.	14.00	660	33	4.62	
Defective castings account bad metal	80.00	20	1	.80	
Ferro-alloys	40.60	38	2	.77	
Total metal		2378	119	$20.12	$20.12
Operating costs				3.50	5.50
Cost of steel in ladle				$23.62	$25.62
Cost of steel in castings.					
Cost of steel in ladle+65 per cent				$36.34	$39.42
Less credit for heads, etc., as scrap				4.62	4.62
Net cost of steel in castings				$31.72	$34.80

Converter.

The cost of steel-making by the converter process is shown in Table IV, where the same comments apply as those made in connection with the acid open hearth process.

The operating costs of $3.50 per ton applies to the making of 150 tons of castings per week in one converter. It will appear very low to some practitioners who have to pay a high price for fuel etc., and whose tonage is lower. A second figure of $5.50 per ton is therefore shown to apply under such circumstances.

Table VI.

ACID OPEN HEARTH [MAKING SMALL CASTINGS].

Raw materials.	Price of raw materials per 2,000 pounds.	Per 2,000 pounds of steel in ladle. Weight used, pounds.	Per cent. used.	Cost.	Cost.
Pig iron	$14.00	300	15	$2.10	
Heads, gates, etc	14.00	660	33	4.62	
Foreign scrap	14.50	980	49	7.11	
Defective castings account bad metal	50.00	120	6	3.00	
Ferro-alloys	40.60	20	1	.59	
Total metal		2089	104	$17.42	$17.42
Operating costs				5.50	8.85
Cost of steel in ladle				$22.92	$26.27
Cost of steel in castings.					
Cost of steel in ladle÷65 per cent (12)				$35.26	$40.41
Less credit for heads, etc., as scrap				4.62	4.62
Net cost of steel in castings				$30.64	$35.79

(12)Of the steel in the ladle, 65 per cent. goes into castings, 33 per cent. goes into heads, gates, etc. 2 per cent. is lost in spattering during pouring. In making small castings, the loss in pouring from a bottom-poured ladle would be much larger than this, and the cost of steel in castings would be increased $1 to $3 per ton, but data is lacking for exact estimates.

The waste of metal of only 15 per cent., shown in Table IV, will also appear low to many whose practice is not as favorable as this, and therefore Table V is given to illustrate the cost under such conditions.

It will be observed that the converter is not in a position to compete on even terms with either the acid or basic open hearth process and must rely on a special grade of work for its field. This field, as is well known, is a manufacture of steel for small castings where the small converter now holds the predominant

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position. Since the electric process will doubtless first enter this same field, it may be well to consider anew the acid and basic open hearth processes from this standpoint.

TABLE VII.
BASIC OPEN HEARTH [MAKING SMALL CASTINGS.]

Raw materials.	Per 2000 pounds of steel in ladle. Price of raw materials per 2000 pounds.	Weight used, pounds.	Per cent used.	Cost.	Cost.	Per 2000 pounds of steel in ladle. Weight used, pounds.	Per cent. used.	Cost.	Cost.
Pig iron	$12.75	1040	52	$ 6.63		1040	52	$ 6.63	
Heads, gates, etc.	14.00	660	33	4.62		660	33	4.62	
Foreign scrap	11.15	190	9½	1.06		350	17½	1.95	
Defective castings	50.00	200	10	5.00		300	15	7.50	
Ferro-alloys	40.60	33	1½	.67		33	1½	.67	
Total metal		2123	106	$17.98	$17.98	2124	106	$19.93	$19.93
Operating costs				6.10	9.55			6.10	9.55
Cost of steel in ladle				$24.08	$27.53			$26.03	$29.48
Cost of steel in castings.									
Cost of steel in ladle+65 per cent				$37.05	$42.35			$40.05	$45.85
Less credit for heads, etc., as scrap				4.62	4.62			4.62	4.62
Net cost of steel in castings				$32.43	$37.73			$35.43	$40.73

Acid and Basic Open Hearth Processes Making Small Castings.

The most important circumstance which keeps the open hearth processes largely out of the field of making steel for small castings, and which often results in open hearth foundries even sending their orders for small castings to foundries equipped with a converter or crucible process, is the large percentage of defective castings made by the open hearth process when producing steel for small castings,—say for example castings thin in section and under 100 pounds in weight. In Tables VI and VII, I have shown the costs of steel in the acid and basic open hearth processes when the percentage of defective castings chargeable to bad metal is large. It may be that some open hearth foundries will deny the suggestion that the percentage of defective

castings due to bad metal is ever so large as the figures given, but we do not think that the practice from which these figures were taken was unusually bad. If a foundry is making 1,000 tons of heavy castings per month and 50 to 100 tons of castings under 100 pounds each, defective castings to the extent of even 25 per cent. of all the small castings would not make a great show in the month's figures unless special means were taken to show separately the percentage of defective castings under and over 100 pounds weight.

Table VIII.
CRUCIBLE CASTINGS.

		Per 2000 pounds steel in ladle.					
Raw materials.	Price of raw materials per 2000 pounds.	Weight used, pounds.	Per cent used.	Cost.	Weight used, pounds.	Per cent. used.	Cost.
Wrought iron	$ 25.50	1360	68	$17.34			
Foreign steel scrap	14.50				1330	66½	$9.64
Heads, gates, etc	14.00	660	33	4.62	660	33	4.62
Defective castings	125.00	10	½	.63	10	½	.63
Ferro-alloys	40.60	12	½	.24	12	½	.24
Total metal		2042	102	$22.83	2012	100½	$15.13
Operating costs				35.00			35.00
Cost of steel in ladle				$57.83			$50.13
Cost of steel in castings.							
Cost of steel in ladle÷66 per cent. (13)				$87.62			$75.95
Less credit for heads, etc., as scrap				4.62			4.62
Net cost of steel in castings				$83.00			$71.33

(13) Of the steel in the ladle, 66 per cent. goes into castings, 33 per cent. goes into heads, gates, etc., 1 per cent. is lost in pouring.

Crucible Process.

Wherever the electric steel-making process has come into use it has been the crucible steel process that has usually been supplanted, with one or two notable exceptions. Therefore it is the crucible steel foundries that view the electric process with the most interest. One important consideration in this connection is however the cost of installation, for this will be at least ten times as much in the case of the electric process as in the case of the crucible process. The cost of making crucible

steel is given in Table VIII, which it will be observed is divided into two parts, the first illustrating the cost when melting wrought iron, which is common practice when making the higher grades of tool steel etc., and the second when melting low phosphorus steel scrap. It is the latter type of practice which steel foundries usually employ and these figures only will be used for comparison.

Table IX.

ELECTRIC FURNACE.

Raw materials.	Price of raw materials per 2000 pounds.	Per 2000 pounds of steel in ladle: Weight used, pounds.	Per cent. used.	Cost.
Steel scrap	$ 9.50	1330	66½	$6.32
Heads, gates, etc	14.00	660	33	4.62
Defective castings	125.00	10	½	.63
Ferro-alloys	40.60	12	½	.34
Total metal		2012	100½	$11.81

Cost of steel in ladle:	In ladle	In casting:
Electric power at 1 cent per kilowatt hour	$28.81	$39.03
" " " 2 cents " " "	37.96	52.89
" " " 3 " " "	47.11	66.76
" " " 4 " " "	56.26	80.62
" " " 5 " " "	65.41	94.49

Electric Steel Process.

The electric steel-making process has two advantages over the crucible process: first, it can use the cheapest form of steel scrap available in the market, and second, it can turn out the highest grade of steel made, the electric furnace surpassing all others in its control over the phosphorus, the sulphur, the temperature and the gases dissolved in the metal. The cost of making steel by the electric process is shown in Table IX which is based upon figures furnished by the makers of some of the important furnaces and from published results of actual steel-melting operations on a commercial scale. It is evident that the chief factor in the cost is the price at which electric power is available and therefore five different estimates are made.

American Foundrymen's Association.

A SUCCESSFUL FOUNDRY COST SYSTEM.

By J. P. Golden, Columbus, Ga.

A practical simple cost system, suitable for foundries doing a business of 125,000 to 150,000 lbs., net, clean, medium, and light grey iron castings per week, with an approximate force of 75 to 100 men.

My object in devising the following system, was to enable me to have a ready means of reference and comparison in the several foundry departments at all times, and incidentally to lower the cost per 100 lbs. for net, clean castings, without *extra clerical force or cost*, or causing undue work for foundry foreman, assistant, or cleaning room foreman. This system is not perfect and could be improved. To do so in our case, would require more clerical force, which would increase the non-producer cost per 100 lbs. net, clean castings. For instance, in case of a pulley with a cracked arm that was to be remelted; without inquiry, I wished to know why it was to be made over, and by whom returned. The system referred to covers this case, also by whom the pulley was made, the time taken in making, weight of pulley, to whom sold, cause of crack, etc. These records are all accessible to both superintendent and foundry foreman under this system.

In the event of a moulder asking for a raise, the system shows either the superintendent or foreman what class of work the man

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has been working upon, his record, his present pay, whether by hour or piece, and the number of pieces lost, as well as the weight moulded, also the means of comparing the wages and output of one man with another.

I also wished to have a method where-by the foundry foreman could see exactly what each department was doing, to allow him to correct any bad practice that he might control, so far as rested with him.

I wished also to know at a glance what the cost per hundred lbs. for clean castings was for last week, or last year, or the average for a year. How many pounds net clean castings were made in any week, or the average for a year, with the per cent. loss for bad castings. As to wage cost alone for 100 lbs. for any week, or yearly average. What the cost per hundred lbs. was for either the non-producers, rumbling department, moulding department, core shop, day or night cleaning gangs.

I also wished to separate the different kinds of castings into classes, with current prices for these castings, for both our shop and customer, so that having the approximate cash value of castings, and deducting therefrom the cost of pig, scrap and coke, wages, and fixed expense per 100 lbs. clean net castings, I would be able to find the approximate cash profit per week.

After a satisfactory trial of the following system for nearly two years, without extra clerical force or cost, (the weekly report being made up in the unoccupied time of a draftsman), it has occurred to me that there might be other members of the association to whom my system might be of interest; therefore, I have submitted this paper.

The system consists of, first: a Daily Cupola Report, the printed form having column for charge, number pounds coke and brand, pounds pig iron and brand, and per cent. silicon and sulphur, scrap, foreign and returns, and total charge, also lines for weekly totals for use in weekly report. Ratio of coke

to iron. Time started blast. Time dropped bottom. Average blast pressure. Per cent. sulphur in heat. Per cent. silicon in heat. Remarks. With each sheet signed by foreman.

Second: the Daily Foundry Report, which is made up by the rumbling room foreman. This report consists of a sheet, with columns for name of moulder, hour or piece rate, number of moulds, number of castings, time of helper, pattern description, with columns for weights of the various classes of work, as pulleys, sheaves, hangers, hanger boxes, pillow blocks, couplings, cane mills, factories, miscellaneous, etc. Also column for number of pieces lost, total weight of each kind of piece lost, and a cause column for same, showing if it did not run, if was crushed, blowed, or what-ever cause of defect. There is a line at bottom of sheet for weekly totals, to be used in weekly report. The daily foundry report furnishes a ready means of comparison of each moulder's record, with his own, or with other moulders, as to quanity of good castings, castings lost, weight and cost of same. This report also shows the amount of good and bad castings for each day, in each class, with the weekly total for each.

Third: there is a book for defective and other castings returned from shop and customers, in which is the following rule:

> "All castings returned by machine shop and customers, before being made over, must be entered in this book, giving cause for making over. Castings returned to foundry from shop or customers, through no fault of foundry, must not be deducted from net foundry castings, and should be considered as foreign scrap. If fault of foundry, they are charged back to foundry and are considered as foundry return scrap."

This book has columns for showing date returned, by whom, description, cause and weight. Without this book, there could be returned defective castings, which was the foundry's fault and made over without the superintendent's knowledge. With the "to be made over" casting book, all castings returned are

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specified therein. If the fault of the machine shop, it is so stated. If returned from customers, this is noted, with date, description, cause and weight. No casting is made over without being recorded in this book. This book being always open to superintendent and foreman, saves inquiries and explanations. Possibly a few examples here will make the value of this book plainer. For example: the superintendent upon examination of this book, finds a record of a split pulley 36 inches 12 x inches—2¼ inch bore, lug broken off in machine shop in splitting, or a record of a pulley 24 inches x 8 inches—2 inch bore, bored too large in machine shop. These cases would not be through any fault of foundry and the weights would not be deducted therefrom. The castings would be considered as foreign scrap. If the record showed a pulley 12 inches x 4 inches—1 1⅞ inch bore, with dirty face, or 12 gears returned by a customer, from no fault, except in excess of the order, or 25 J. I. Castings returned by customer with too large cores. These latter three cases would be the fault of the foundry, and the weights would be deducted from clean net castings for the week in which they were recorded, and considered as return foundry scrap.

Fourth: the Weekly Foundry Report Sheet. This sheet is made up from the daily foundry report, and cupola sheets and the book (to be made over castings). On this sheet, provision is made for record of bad castings returned from foundry, shop or customer, by classes, as well as the good castings made. The total of good castings minus defective castings gives net good castings for week. The average per cent. of all castings lost is given, with the per cent. loss in each class, with the total pounds pig and foreign scrap charged in cupola, and the net good castings deducted therefrom, we find the per cent. lost in remelt, cupola droppings, gang-ways, etc. This loss is apt to deceive one, for where the foundryman would estimate a loss of 3 to 5 per cent. on a certain class of work, he might overlook the fact that he had not taken into consideration the remelting loss of gates. For instance: if upon exceedingly light work with 25 to 40 per cent. gates, the loss from continued remelting etc. might run as high as 8 per cent. or 10 per cent. The weekly

foundry report also has a record of total melt taken from daily cupola sheet, which with net good castings deducted gives per cent. bad castings, gates, etc. of total melt, including foreign scrap, returns and pig. In a division headed cupola charge, is given the number of pounds pig iron, foreign scrap and coke, with current price of each and total cost per week. To these amounts are added the total wages, giving a total of material and wages for week, which divided by the net good castings, gives the cost per 100 lbs. net castings, including pig iron, scrap, coke, wages.

The weekly report also has separate divisions for non-producers, rumbling department, moulding department, core shop, day and night cleaning gangs, in which the wages of each class of men in each division are given separately, by total, and the wage cost per hundred lbs. For instance: in our own shop, the non-producer division includes the foundry foreman, assistant foreman, pulley man, craneman, the clerk (who is also rumbling room foreman), cupola tender, cupola helpers, and carpenter, the separate wages per week of each being given, the total of all, and the wages cost per 100 lbs. net castings. The weekly report also embodies the grand total wages cost per 100 lbs. and this is the most important item, for both foreman and superintendent, for this item is one which the foreman can control to the greatest extent, and which speaks the loudest in favor of the system.

It may be of interest to the members of the Association to know that since the adoption of this system, nearly two years ago, each period of six months' average records, have shown a decided decrease in the wages cost per 100 lbs., amounting to nearly 20 per cent. since adopting the system.

In connection with the weekly report is a detailed report of the pounds of good castings, to whom sold or charged, and price for each lot, and from this sheet is prepared on the back of the weekly report, a statement giving the estimated profit or loss for week.

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And lastly, there is a ready reference sheet (headed Comparison of Per Cents. Wages Cost per 100 lbs. in different departments of foundry from weekly foundry report) giving the comparison by weeks and the average comparison at the end of each year of the following items after date. Net good castings for week, castings killed in machine shop, with columns for the per cent. loss of each of the several classes of castings, each class in a separate column, gives a ready means of comparison in that class for all of its weeks.

There are also columns for the cost per week per 100 lbs. net castings, including pig iron, scrap, coke, and wages, the wage cost per 100 lbs. in the non-producers, rumbling and moulding departments, also the core shop, day and night cleaning gangs, with a column for grand total wage cost per 100 lbs.

Both the superintendent and foreman have access to the several reports, giving each the means of knowing the actual conditions in all departments of the foundry at all times.

This system gives the foreman the means of remedying a small or defective output by the knowledge of the cause producing it, and to place each moulder upon the class of work to which he is best fitted to increase the general output.

It is an encouragement for a good foreman to know that every gain in his record is brought to the attention of the superintendent, and should he be a little careless at times, he knows that the report will show it, and he is more apt to avoid a bad report. Moreover, it sets a pace for him to keep up to so if the production is a little light the first part of the week he can often turn out a little more the last part to keep up the production.

Also in the case of a change in foreman, not only does the superintendent have his judgment to base the worth of the new man upon, but the records themselves show the standing of the new man in comparison with the old, in the average wage cost per hundred lbs. net clean castings under similar conditions.

The system also furnishes a basis for closer estimates than formerly, upon work a little out of the usual run, by knowing exactly what prices can be accepted for the regular work. The foundry foreman in this case is allowed nominal control of the foundry, hiring and discharging his men, fixing their wages, and increases in pay for his men are by his recommendations, subject to approval of superintendent.

As the system consists simply of a set of forms which can be cheaply procured from any printer, which forms are filled in each week, those of the members who are interested, may get a clearer idea of this system by referring to the sample forms which I have at your disposal.

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DAILY FOUNDRY REPORT.

Goldens' Foundry and Machine Co., Columbus, Ga. Date_____

NAME	Hour or Piece Gets	Number of Moulds	Number and Castings	Help	PATTERN DESCRIPTION	Pulleys	Sheaves	Hangers	Hanger Boxes	Pillow Blocks	Coupl-ings	Cone Mills	Lummus	Factory	Agricul-tural	Miscel-laneous	Number Pieces Last	Weight	CAUSE

SAMPLE SHEET FROM "CASTINGS RETURNED FROM SHOP AND CUSTOMERS, TO BE MADE OVER."

NOTE:

All Castings returned by machine shop and customers, before being made over, must be entered in this book, stating cause for being made over.

Castings returned to foundry from shop or customers, through no fault of foundry, must not be deducted from net foundry castings, but should be considered as foreign scrap; but if fault of foundry, they should be charged back to foundry, and considered as foundry return scrap.

All castings returned by shop or customers, in excess of number ordered, will be charged to foundry the same as defective castings, and placed in foundry return scrap, unless otherwise ordered by superintendent.

SAMPLE OF ENTRY.

Date Returned	By Whom Returned.	Description	Cause	Whose Fault	Weight.
Apr. 26, '09	Our Mch. Shop	1 S. B. Pulley 36 x 8—2 7/16 in. bore.	Bored too large	Mch. Shop	240 pounds
Apr. 29, '09	Our Mch. Shop	1 Split Pulley 24 x 6—2 5/16 in. bore.	Broke lug in splitting	Mch. Shop	120 pounds
May 3, '09	Customer	12 Gear Castings P. 2.	Cored too large	Foundry.	14 pounds
May 5, '09	Foundry	1 D. B. Pulley 36 x 8—2 13/16 in. bore.	Blow hole in face	Foundry.	260 pounds

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WEEKLY FOUNDRY REPORT.

GOLDENS' FOUNDRY AND MACHINE CO.
COLUMBUS, GA.

FOR WEEK ENDING FRIDAY, 19

	Pulleys	Sheaves	Hangers	Hanger Boxes	Pillow Blocks	Couplings	Cane Mills	Laminas	Factory	Agricultural	Miscellaneous	Total Weight
Bad castings returned from foundry												
Total pounds good castings made												
Defective castings returned from shop and customers												
Net good castings for week												
Total amount ( )												
Average per cent. of castings lost.												

Total pounds pig and foreign scrap charged in cupola

Net good castings for week

Remainder.

Per cent. lost in remelt, cupola droppings, gangways, etc.

Total melt

Net good castings

Per cent. bad castings, gates, etc., of total melt

Including foreign scrap, returns and pig

CUPOLA CHARGE.

Pounds pig iron @ per hundred $

Pounds foreign scrap @ per hundred

Pounds coke @ per hundred

Total Wages $

Total $

Cost per hundred pounds net castings including pig iron, scrap, coke, wages. $

Material cost per hundred pounds net castings made as per sheet $

Total cost per hundred pounds net castings made as per sheet $

PROPORTIONATE WAGE COST PER HUNDRED POUNDS IN DIFFERENT DEPARTMENTS

NO.	NON-PRODUCERS	WAGES.
	Foundry Foreman	$
	Foundry Assistant	
	Pulley man	
	Crane man	
	Clerk	
	Cupola tender	
	Cupola helpers	
	Carpenters	
	Watchman	
	Total $	

Wages cost per hundred pounds net castings. $

NO.	RUMBLING DEPARTMENT	WAGES.
	Foreman	$
	Assistant	
	Men	
	Total $	

Wages cost per hundred pounds net castings, shipped, cleaned, and ready to ship. $

NO.	MOLDING DEPARTMENT	WAGES.
	Molders (White)	$
	Helpers (White)	
	Helpers (Black)	
	Total $	

Wages cost per hundred pounds net castings. $

NO.	CORE SHOP	WAGES.
	Foreman	$
	Coremakers	
	Help	
	Total $	

Wages cost per hundred pounds net castings. $

NO.	NIGHT CLEANING GANG	WAGES.
	Headman	$
	Men	
	Total $	

Wages cost per hundred pounds net castings. $

NO.	DAY CLEANING GANG	WAGES.
	Headman	$
	Men	
	Total $	

Wages cost per hundred pounds net castings. $

GRAND TOTAL WAGE COST PER HUNDRED POUNDS $

NOTE

Castings returned to foundry from our shop and customers, through no fault of foundry, must not be deducted from net foundry castings, and should be put in foreign scrap pile.

Weekly foundry report, made up from daily foundry report, and cupola sheet.

NOTE

Castings returned to foundry from our shop and customers, through no fault of foundry, must not be deducted from net foundry castings, and should be put in foreign scrap pile.

Weekly foundry report, made up from daily foundry report, and cupola sheet.

COMPARISON OF PER CENTS. WAGES COST PER HUNDRED POUNDS. &c., IN DIFFERENT DEPARTMENTS OF FOUNDRY. FROM WEEKLY FOUNDRY REPORTS.

19 ___ GOLDENS' FOUNDRY & MACH'E CO. WEEK ENDING	Net good castings for week	Castings billed to machine shop	Total average per cent. machine cost	Per cent. pulley castings cost	Per cent. sheave castings cost	Per cent. hanger castings cost	Per cent. hanger bit thatings cost	Per cent. P. block castings cost	Per cent. coupling castings cost	Per cent. cane mill castings cost	Per cent. hammer castings cost	Per cent. factory castings cost	Per cent. agricultural castings cost	Per cent. miscellaneous castings cost	Per cent. cost in repair, repairs, gauges, &c.	Per cent. bad castings, gates, &c. of total, including P. S. return, &c.	Cost per 100 pounds net castings, including pig iron, coke and wages	Pattern-making department wages cost per 100 pounds net castings	Moulding department wages cost per 100 pounds net castings, shipped, cleaned and ready to ship	Molding department wages cost per 100 pounds net castings	Core shop wages cost per 100 pounds net castings	Right Cleaning Gang, wages cost per 100 pounds net castings	Day Cleaning Gang, wages cost per 100 pounds net castings	Grand total wages cost per 100 pounds

AMERICAN SOCIETY,
DEC 14 1909
OF CIVIL ENGINEERS,
NEW YORK.

American Foundrymen's Association.

PROCEEDINGS THIRTEENTH ANNUAL CONVENTION

CINCINNATI, O., May 18-21, 1909.

The Thirteenth Annual Convention of the American Foundrymen's Association was held at Cincinnati, O., on May 18, 19, 20 and 21, 1909.

The following is the official report of proceedings:

FIRST SESSION—TUESDAY AFTERNOON, MAY 18.

The first session was called to order at about two o'clock Tuesday afternoon, President L. L. Anthes in the Chair.

Prefatory to the delivery of his Presidential Address, Mr. Anthes said:

Ladies and Gentlemen:

For the last five years the American Foundrymen's Association has been increasing in membership very rapidly, and it is my privilege possibly this year to extend the welcome to more delegates than any of our Presidents have ever been able to greet in a like capacity before.

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From a personal standpoint it seems significantly appropriate that I should be here during my term of office opening a convention in Cincinnati, because it was in this city that I first attended a foundrymen's association, and also in this city that I first heard of The American Foundrymen's Association some six or seven years ago.

My interest in the American Foundrymen's Association has increased from year to year to the extent that I managed to get into the executive "ring", as I may call it—no inference to be drawn—and the members of the Association have been kind enough to place me at the head of an Association of which I myself—and I am sure every one of you who are connected with it, and all of our members absent today from this meeting, may feel justly proud.

If you will grant me your indulgence, I will read the address which I intend to make to you this afternoon, because I am one of those people who like to talk right at the people I am addressing, and stick to my text closely.

ADDRESS OF PRESIDENT ANTHES.

From a personal standpoint it seems significantly appropriate that this presidential address to you at the Annual gathering of The American Foundrymen's Association should take place in the City of Cincinnati; for it was here that I first attended a foundrymen's convention (that of the National Founders' Association in 1903) and it was here that I first heard of the A. F. A.—thus making a happy round of circumstances. Being the centre of a large iron and steel working area, besides lying upon the borderland of the North and the South, emphasizing the industrial progress of the one and the world famous hospitality of the other,—Cincinnati proves an ideal point for a gathering representing the metal interests of the whole North American continent. There is no reason why we should not have come to Cincinnati and every good reason why we should,—so here we are. I feel safe in saying that the present congress (nothing political inferred) will be one of the

bright spots in the history of The American Foundrymen's Association, and we sincerely trust that our sessions will be as productive of good results as your cordial reception and entertainment will be of pleasant memories.

Those who have attended the conventions and followed the progress of The American Foundrymen's Association for the past few years, cannot but realize that the organization has grown to large proportions both in membership and in importance. In fact it has been found necessary to sub-divide the Association so that the various branches of the metal industries represented might emphasize their individuality and develop along their own peculiar lines without restraint. Thus we have The American Foundrymen's Association proper, reflecting in a measure the grey iron and steel industries, with its affiliated bodies, The American Brass Association, The Foundry Supply and Manufacturers' Association, The Associated Foundry Foreman, and now the steel interests are inclined to form an additional section. All these branches work in co-operation with the parent body, and owing to the harmonious relations existing, good results are the outcome. And it is vitally necessary that harmony and broadmindedness should continue if these good results are to multiply. Careful consideration of the rights of others, and earnest endeavor on the part of the various executives, coupled with a willingness of the members to give a proportion of their time to the demands of the office they hold, are imperative as responsibilities increase. In a rapidly growing body such as we have, representing such an important branch of American Industrial life—not only national but continental—yes, I might say universal in significance, petty and personal grievances and desires must be put to one side and the broader and more unselfish policy of furthering the common good adopted. We have struck the right key note—let us keep in tune.

The educational features and technical requirements of all branches of industrial trade are appealing to the world today as they never did before. The necessity of a deeper knowledge—a more comprehensive grasp of the laws of nature which bear upon industrial development, are felt, and international

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competition demands that America must not be backward to encourage this development. Especially is this so of the metal industries—the greatest of all American industries and which yet hold many secrets to be worked out in the laboratory and in the foundry, and more particularly by the practical man who superintends and upon whom depends the results to be obtained from the intelligent application of what he knows regarding the raw materials at his hand. So much centres upon some little detail, and many an experiment has been given up as a failure because that one little detail was not mastered. It may have been the iron—it may have been the sand—that was at fault—the experimenter did not know—he possibly had the analysis of the iron (the A. F. A. was responsible for that) but what about his sand? It came from the same heap he had drawn from for years,—beyond that he knew nothing about it,—another opportunity for the A. F. A. And here comes a delicate point. The American Fundrymen's Association was created to solve difficulties for the foundryman—but it must be borne in mind that the solution of these difficulties cannot be arrived at with an empty treasury. Experiments cost money and without money we can have no experiments, and without experiments no results. Some months ago, in accordance with a resolution passed at our last Annual Meeting, the members were called upon to vote for or against the raising of the annual fee of $5.00 to $10. It was felt, and also proven, that the sum of $5 per capita did not begin to meet the requirements of our increasing work. The result of the canvass was not altogether satisfactory. Though the majority of those from whom replies were received voted in favor of the raise in dues, the total vote was insufficient as it did not represent two-thirds of our membership such as is necessary to amend the constitution. I do not wish to assume the attitude of preacher exhorting his flock to loosen their wads for the salvation of the distant heathen. This is a business proposition. The fee you annually pay is not a contribution—it is an investment, and if it were not a paying investment you would not be here. You are helping to sustain the life of your own trade and no life should be sacrificed merely because it costs money to live. The A. F. A. is the hub of foundry progress, and we surely will not stop the chariot of state because we are stingy with the axle grease.

Dr. Moldenke and myself made it a point to wait upon the National Founders' Association which met in convention in New York last November and upon the approval of our Executive Committee asked that body to confer with us on the advisability of establishing an endowed laboratory and bureau of standardization for the metal industries. The members of the N. F. A. approved of the move and appointed a committee to act in conjunction with our committee. Owing to the unsettled condition of industrial and financial affairs during the past year, it was deemed advisable to lay the matter over until times were more encouraging. Just how an endowed fund for this work is to be raised is an unsolved question. Perhaps some philanthropist who owes his fortune to the development of the iron and steel trade will take the initiative and establish a generous fund to which others may also contribute, or the bureau may be established and operated as a department of some technical institute already in existence.

Every year—probably every day something new is being learned of metallurgy and its industrial application. An important discovery may be made amidst the most humble surroundings—a discovery which may be of great service to the trade at large and which could be imparted by the discoverer to his fellowmen without any commercial loss to himself. But how is this discovery to be made known where it is something that requires further investigation and experimenting, but where the discoverer lacks the necessary funds, time, equipment or training to carry along his work to a conclusive issue? Things are at a standstill and something is lost which possibly might have saved millions in money. We are a wasteful people because we have not learned to conserve our natural resources, and many a dollar goes to the dump because of our ignorance. Now if we had a bureau where reports of discoveries could be made to practical men, the necessary attention could be given, and in many cases beneficial results obtained. The United States Steel Corporation has recognized the importance of investigation and is operating an experimental plant to further its own commercial requirements. If we possessed a similar plant, perhaps not quite so pretentious, a record could be kept of experiments and investigations, and any discovery that had been made or affirmed

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could be published in our trade papers or a journal distributed by the bureau for the benefit of the foundry trade. Added to this the various details of foundry practice could be standardized and formulæ issued in the shape of a hand-book, to be used by the foundryman as a practical guide to his work. Good technical literature properly prepared is an invaluable aid to the progressive operator of a plant.

We all approve of technical schools, recognizing the necessity of training young men to practically apply the knowledge that has been imparted to them. But of first importance is the necessity of imparting correct knowledge. Let the text books of these technical schools be compiled by men who have had practical experience, and let the contents of these books be the very latest and best procedure relating to the trade they are endeavoring to master. Had we a bureau manned by men who were qualified to conduct experiments and compile these text books, we could be confident that the training these students were getting at the technical schools was in accordnace with up-to-date foundry practice. It is the thirst for knowledge, the desire to know what others are doing, that brings the foundrymen together year after year. This is the progressive spirit, and the more numerous the channels for distributing knowledge the more rapid the progress.

It is only by an educational campaign such as is being carried on by the A. F. A. and allied organizations that the young foundryman, (and I am glad to see his number increasing at the conventions) is going to reap advantages that his father never dreamed of. All honor to the pioneers of our trade—they worked out the problems and prepared the way, and we of the younger generation are getting the benefit.

One great and good feature of our gatherings cannot be overlooked, and that is the good-fellowship and broad-mindedness the conventions encourage and develop. We no longer cling tenaciously to trade secrets and close our shops to all comers in search of knowledge—this selfish and I may say barbarian

spirit is gradually dying out and a more liberal attitude is taken by the foundryman toward his fellows.

Foundrymen, like followers of other trades, have been held back by what may be termed hide-bound superstitions regarding what can and what cannot be done in the molding shop. They had been used to certain conditions and it was like losing a dear relative to break away from these conditions. Yet the foundrymen were not to blame, they were doing the best they could and it was not till they got more light that they could see more plainly. A hide-bound foundryman has to be handled very much as the missionary handles the heathen and then often the convert is more zealous than the missionary—when a man begins to see beyond the confines of his own shop to recognize that he is not a slave to existing conditions then he begins to see possibilities that he never before realized. But you must try to catch the foundryman young—to turn his mind into progressive channels while it is in the formulative stage—he is a much harder proposition when his mind is set. It was only last night that I heard a foundryman claim that he had no use for the foundry chemist; that he would rely on his judgment of fracture every time—and then in practically the same breath this man declared that he was "too antiquated" to take up these new things. Here was a confession in an honest out-spoken manner and the fact that he wished to convey contained far more truth than one might imagine—it bore out the time-worn proverb—"It is hard to teach an old dog new tricks."

One of the most notable advances in the development of the foundry has been the introduction of the molding machine. What it has already accomplished, covering a wide variety of work, is known to the majority of you and is being demonstrated at this convention. But I wish to state to you that the use of the molding machine has been limited by our own limited knowledge of foundry practice. The more facts we learn regarding the physical properties of the elements we work with, the more efficient will we find the molding machine. Owing to our scanty knowledge of the properties of molding sand alone, we are incapable of applying the molding machine to work that will ulti-

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mately be taken care of by this great factor in economical operation. During the past year I might incidentally point out Dr. Moldenke has been making careful experiments with molding sands for all parts of the country, and has prepared a tabulated report of his work which will be laid before you. Another serious problem that faces the molding machine man is "What is the most economical and efficient way to handle the molds turned out by the machine?" The true economic value of a machine cannot be determined until that machine is worked to capacity; and I ask the question "Are our facilities adequate to work our molding machines to their limit?" I am afraid not. To assist our members to the solution of this problem we have endeavored, and with a degree of success, to obtain papers along this line from the best authorities upon the speedy handling and pouring of molds. Continuous pouring and sand conveying has been adopted by a number of large plants in order to economize floor space, equipment and labor, and we are pleased to state that we will have addresses from men who have treated the possibilities of continuous pouring. These papers, I trust will bring out good discussions, and I wish to emphasize my belief that the discussions are the life of our meetings. As the readers of these papers are quite ready and willing to answer questions, it is to be hoped that our members will attend the sessions and not be backward in asking for information. We have also tried to bring forward what we believe to be recent advances made in the foundry trade and to have papers from the men instrumental in these advances. It has been our aim to have these addresses illustrated where possible, and accompanied by exhibitions of practical results, in order to make the sessions more attractive. Though we have failed to obtain certain of the papers that we desired several gentlemen have kindly consented to lay before us the results of their efforts and we sincerely trust that appreciation will be shown them in the shape of a full attendance at the various sessions.

And now, gentlemen, I wish to thank individually and collectively the officers and members of The American Foundrymen's Association for the extreme kindness and co-operation they have accorded me during my connection with this organization, both as a bench member and as one of your executives. I have no re-

grets and trust that you are like-minded. Nothing but pleasant memories attend my thoughts regarding you, and I think we can congratulate one another upon the magnificent proportions and dignified position our association has attained. Once more I thank you one and all, and trust that we may continue to gather harmoniously for many years to come.

PRESIDENT ANTHES: The papers which have been prepared and will be read to you have been written with the purpose of bringing out discussion and in order to develop interesting points in your experience. You will no doubt be able to contribute of your knowledge and experience facts and ideas that the authors of the papers have not thought of, or you may be able to present a solution of some problem that the essayist has been struggling with.

One of the men who is to deliver a paper here this week on a most advanced line of work says that he has obtained a great deal of information and valuable knowledge from others.

I note we have a great counter attraction down-stairs in the way of molding machines and other practical operations; but you will have ample opportunity to visit and inspect the exhibition down-stairs at times when these sessions are not going on. We have nothing like that to attract you here, but here you will get something for nothing. We are not charging you an admission up-stairs, you will never find out what you are missing or what you are getting unless you attend all these sessions of the convention. I dare say that every man who takes part in the discussions or who is an attentive listener here will go home feeling he has learned far more this year than he had thought it possible for him to learn.

REPORT OF THE SECRETARY-TREASURER

It is but natural that the period of depression through which the Foundry Industry is passing, should in a great measure be

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reflected in a statement of the condition and activity of the Association. And yet, in spite of the difficult collections, and the great number of members not in good standing at the present time, interest in the work of our Association is on the increase, and the information disseminated is no longer falling on so much barren ground as formerly. The enormous attendance at our conventions, stimulated without doubt by the magnificent working exhibitions—a tribute to the educational tendencies of the day—is bringing about an interchange of thought on desirable lines of foundry progress, the outcome of which we see reflected in our convention program. Probably two lines of foundry economy have been more or less studied during the last year, and they are the Permanent Mold, with the elimination of economic waste where success has obtained; and continuous melting, with the resulting output increase in existing plant units.

The correspondence passing through the Secretary's office has reflected the above mentioned tendencies rather sharply, and would seem to indicate that before long we will find foundrymen understanding their cupolas better, and manipulating them to suit their floor conditions instead of vice versa. The permanent mold will probably still further specialize in the foundry, gradually drawing from the general trade those certain castings which have to be made very cheap and in quantity. Separate plants, of comparatively small size, but enormous capacity, fully equipped to do just one line of work, turning scrap into finished castings of uniform composition and specified service requirements, will be located where the proper commercial conditions obtain, and another chapter added to the growing volume on modern foundry practice.

Deducting from our membership list those whose case may be termed "hopeless," we have today 724 firms and individuals enrolled, the majority of whom we have been able to serve during the year with foundry information of one kind or another, in addition to the regular channel of our Transactions. The pleasant, though onerous, work thus entailed has naturally militated strongly against giving proper attention to reviewing the technical press for the benefit of all our membership, as well as the con-

duct of the research work outlined last year. The value, however, to those whom we have thus assisted, evidently prompted many in sending their votes for increased dues, to remark that the money thus spent was their best paying investment.

Agreeable to resolution by the Toronto Convention, ballots were sent out recently asking for a vote on the proposed increase in annual dues to ten dollars. The purpose was fully explained in an accompanying circular. One hundred and forty-three votes in favor were received, forty-four against. The affirmative being less than the two-thirds vote of the entire body required, the proposition failed of acceptance. While this is much to be regretted, evidently the hard times are to blame. Of the affirmative votes there were but few in which there was not added some commendatory remark, thus encouraging your Executive Board greatly, and giving valuable suggestions. One point seemed to stand out specially. A desire to have a bound volume of the Transactions at the end of each year, as is the custom of the great engineering societies. Were our finances ample, this would be a very fine thing to do.

The research work inaugurated by the Association, has been continued. Apparatus has been purchased, and it is expected most of this to be returned, so that the fund may benefit thereby when the object has been obtained. Much apparatus has also been made in connection with the molding sand tests, and some melting tests with briquetted coke dust, with a view of desulphurization, have been made, though this is not sufficiently advanced for a report. A large amount of work has been done on the molding sands, of which an admirable collection was gotten together. The balance left in the fund to date is $433.39, expenditures having only been made for apparatus, hired labor, and small incidentals. The fund should last several years yet, and interesting and useful results be obtained.

Our Committee on the Prevention of Accidents in Foundries had a very busy time for a few months, and got up a remarkable series of statistics, calls for the copies of which have come from everywhere. Our Committee on Industrial Education, has

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quietly but none the less effectively spread information on this important subject, and here also have there been many calls for literature and special investigations.

Our relation with our sister associations has been most cordial. The executive boards have met jointly during the year to consider the problems arising out of the Exhibit feature now part of the Conventions. We have taken the broadest possible stand in these matters, believing that anything of educational value to the industry as an entirety, should be encouraged as much as possible and made to be of direct benefit to us as well. Herein we differ very much from foreign practice, one great Association of an Industrial nature allowing no exhibits whatever, and even locking the doors during the sessions.

The financial report for the year is as follows:

Income from dues and subscriptions to Transactions		$2,635.15
Balance from last year		37.74
Total		$2,672.89
Expenditure, for Transactions	$ 765.60	
" for Printing	209.38	
" for Salaries	900.00	
" for Postage	432.00	
" for Accident Committee	215.61	
" for Toronto Convention	142.36	
Total		$2,664.95
Balance		$ 7.94

A glance at the items of expenditure and comparison with previous reports will show the change that has come in the operation of the Association affairs. By joint resolution of the Executive Boards of the American Brass Founders' Association, and our own, an interchange of Transactions has taken place, and thus membership in one association gives the advantages of both. This necessarily has increased the size of the edition printed, as well

as the postal expenditure. The printing account has also increased as our membership is larger, and great efforts were made to obtain new members as well as hold the old ones. The convention expense has now become quite heavy, as formerly many petty expenses were provided for by the local committee of entertainment, this consisting of foundrymen, who were glad to help along the cause. Now this is borne by the Association.

It is to be hoped, therefore, that so long as the Association will not grant a larger income, that our membership will increase sufficiently to enable us to do more. There should not be a large balance at the end of a fiscal year, for any expected surplus should be promptly placed into publication or research work. It were better, however, that we need not sail quite so close to the wind.

May the hard times, therefore, soon pass, so that with the interest everywhere manifested, we may grow larger and stronger, and our industry benefit thereby correspondingly.

Respectfully submitted,

RICHARD MOLDENKE,

Secretary-Treasurer.

SECRETARY MOLDENKE: I have received a letter from Mr. Field, Chairman of Committee on Standard Specification for Foundry Pig Iron, asking that the report of the Committee be passed until his arrival from Indianapolis, Thursday morning. I will say the Committee had a number of meetings at Philadelphia, with members of the American Society for Testing Materials, with the Eastern Pig Iron Associations, etc., and have gone very thoroughly through the question of specifications, with the result as set forth in the report, which you will find in print. They were thoroughly threshed out. The matter will be taken up on Thursday morning, and if any questions arise a discussion of them can be had at that time.

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In connection with the report of the Committee on Prevention of Accidents in Foundries, a request has been made by a gentleman interested in industrial insurance to be permitted to say a few words upon that subject; so, after Mr. West has read his report, we will probably hear from our good friend Mr. Chatfield on that line.

PRESIDENT ANTHES: I will now call on Mr. West, one of our Past Presidents, a very enthusiastic foundryman, and a man who has always done all he could for the foundrymen and who is still continuing his good work. You will evidence this in the report, which he is now going to submit to you.

Prefatory to his formal report as Chairman of the Committee on Prevention of Accidents in Foundries, Mr. West said:

MR. WEST: A year ago we brought up before the convention the matter of prevention of accidents in the foundry, and a committee was appointed with your speaker as Chairman. The Committee has been laboring since its appointment to carry out the work committed to it. The statement was made at that time that the first thing of importance for the Committee to undertake was to endeavor to get all the information possible as to the causes of accidents in foundries.

Your worthy Secretary assisted the Committee in sending out question blanks and soliciting answers to the same. The work apparently did not receive much attention at the start, but was finally more encouraging than we had anticipated. Some 6,000 letters were sent out to which over 1,000 replies were received. The Committee was gratified to note the interest taken by many in the work, some members going to the extent of writing letters two or three pages long in order to impart the fullest information and their best ideas on the subject. All information received was compiled in the preliminary report which was duly distributed.

I want to call your attention before presenting our report to the fact that the soliciting of information as to what are the

underlying causes of accidents and the agitation of the subject brought about by that inquiry has accomplished more good than a good many of you probably realize. One of the beneficial results which I wish to especially refer to now is the articles which have appeared in our trade magazines and in the newspapers all over the country which have brought to the attention of legislators the fact that all the blame for accidents does not rest upon the employers. A year and a half ago I believe you would have found very few articles on that subject; in fact, it was all the other way; but to-day we are pleased to say that public opinion has greatly changed. For the last six months I have failed to find any articles which lay all the blame for accidents upon the proprietor.

A New York lady of considerable ability, connected with Commons and Charity has been investigating the question of accidents in Pittsburg, under what was called the "Pittsburg Survey." Some reference to this lady is made in the report which I will present to you; but I wish to state that much literature was placed in the hands of this lady bearing on the subject which aided her in placing the blame where it belonged. I merely mention this so that you may all be doing a little thinking along that line and be prepared to realize that your Committee has done a little good in its past year's work.

Mr. West now read his report (see page 55 of Transactions.)

DISCUSSION ON ACCIDENTS IN FOUNDRIES.

MR. WEST: I ask your attention, gentlemen, for a few minutes longer to outline what I think to-day is the next move, to help us keep down the great number of accidents that we have in this country. I know you will be surprised when I say that I have now in mind accidents due to Fourth of July celebration. I speak of that as an illustration chiefly of what we have to combat here in this country to-day. Our Fourth of July celebrations represent the maiming and killing during the last ten years

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on an average of over 5,000 people; a slaughter that could be stopped without the outlay of a penny, or without any care or worry on the part of anybody. But how are attempts to stop it received? Go into any community and make the attempt, and you will begin to understand what we have to contend with when we try to make the American people understand where the responsibility for accidents really lies. If we could make them realize that, we would have done a great thing.

I just want to mention a little experience which your speaker had during the last three months in the little burg of Sharpsville, Pa., in trying to have a "sane and safe" Fourth of July. Considerable work was undertaken to persuade the council to pass an ordinance similar to the one in existence in Cleveland to-day. Our little society branch of the American Anti-Accident Society in Sharpsville worked with our council to pass the ordinance. We thought we had succeeded, but one objection after another was raised, and the matter never came to an issue. Your speaker took the matter in his own hands and started out with a petition to see whom he might secure to endorse the passage of such an ordinance. He succeeded in obtaining the signatures of the best people in the community, the people worth while, the people of responsibility, of thought and of intelligence. We felt sure we had enough to influence the council to pass the ordinance; the affair leaked out, and a little store-keeper who had some fireworks to sell on the Fourth of July got up a counter-petition. He secured the signatures of all the riff-raff and the fellows who want a good time no matter what is the result, together with the store keepers who wanted to sell fireworks. Both petitions were presented to council, and the good people were turned down by the class that cause your accidents to-day. They will rule in every community where politics cuts any figure. Now gentlemen, that is getting down to the foundation. It seems a strange question to bring before a foundrymen's convention that of a "Sane and Safe" Fourth of July; but there is an underlying principle, a problem which if we could solve it successfully would greatly aid in preventing many of our accidents.

PRESIDENT ANTHES: Gentlemen, we are greatly indebted to Mr. West and his Committee for the very exhaustive

work he has put on that report. All who will examine this little pamphlet cannot fail to realize the large amount of research and investigation that has been required to present these results to you. Now this is a matter which ought to appeal to every one of you, because I do not suppose there are any of you who have not experienced some trouble in the way of accidents in your foundries, and who have not at times regretted that certain measures had not been taken that might have prevented the accidents.

Somewhat along the same lines as Mr. West's report, in fact one of the points upon which he touched, is the subject of foundry insurance, that will be spoken of a little later on. First, I want to call upon the gentlemen present to discuss Mr. West's report. This report has been the fruit of too much hard work and refers to a subject of too great importance to be allowed to pass by without the foundrymen showing that they are interested in it. I will be very pleased to have the subject actively discussed.

MR. MURPHY: I would suggest, Mr. President, that during the coming year you kindly make note of the facts and obtain if possible data with reference to the proportion of accidents in foundries occurring in wet towns as compared with those occurring in dry towns. (Applause.) I believe that a great many accidents in foundries and other places arise directly or indirectly from the small pots of tarantula juice that our employes carry in their pockets occasionally. You will notice in most shops that it is the ignorant man that takes the least care of himself and that is the most liable to meet with accidents. You will find, if you run down the matter very closely, that the men who meet with accidents are those who are accustomed to spend the greater part of their leisure hours in bar rooms, or who carry flasks in their pockets. I have been over every section in this country and have always done my share just as honestly as any man could do it in building a good substantial rigging and keeping the machine in good order; yet I have failed completely in preventing accidents to the more ignorant classes in the foundry. I really think that the suggestion of the last speaker ought to be worth something. I think that in dry towns where the

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men cannot get their liquor and carry it in their pockets, they are more apt to come to their work sober the next morning, and it has an appreciable tendency toward lessening the number greatly of minor accidents.

SECRETARY MOLDENKE: Perhaps I might say a few words in reply to Mr. Murphy's suggestion as to looking statistics in wet and dry towns. I would say I had the pleasure of sending all this matter out. My boys, my girls, my wife and myself, and the postmistress of Watchung were kept busy for two months to get this material out, and we do not wish to do any more of it if we can help it. I think that our work so far as the collection of statistics on accidents in foundries is practically complete. We have now got it in such shape that the Committee can take it up and consider it further. But the last speaker's point was well taken. Smoking has also caused trouble. In fact one large plant in Mr. West's neighborhood was burned down because a man who was drinking also smoked and carelessly set the place on fire and wrecked it.

MR. WEST: Unfortunately, being a little hard of hearing I did not catch all that was said by the previous speakers; but I would like to state that our report shows that there were very few accidents from intoxicants. More accidents are caused from smoking, in our shop, or as many as from drinking. As I have in mind one case where a young man lost his life by crawling into the cage of a crane and asking the operator for a light and some tobacco, and the operator trying to accommodate him and attend to his work at the same time misunderstood his request and instead of hoisting up he lowered down, so that in an instant the young man was killed. This matter of lighting pipes and running around smoking in shops I do not think has been given full justice in our report. I think if the matter were looked into more closely you would find that a great many accidents are due to the smoking habit. The men run around with pipes and cigarettes, and thereby become inattentive to their work. (Applause.)

MR. SPEAR: I move you, Mr. Chairman, that the report of the Committee on the Prevention of Accidents in Foun-

dries be accepted and filed, and the Committee discharged with thanks.

The motion carried unanimously, and President Anthes returned the thanks to the Association from the Committee through its Chairman, Mr. West.

MR. WEST: Mr. President I forgot to state that I shall be pleased at any time to receive any reports or suggestions from any of the members of the Association, or their friends, looking toward the prevention of accidents. (Applause.)

PRESIDENT ANTHES: We will now be pleased to hear from Mr. Chatfield, of Detroit, Michigan, on the question of "Industrial Insurance."

INDUSTRIAL AND LIABILITY INSURANCE.

Address by Mr. L. O. Chatfield, President Phœnix Preferred Accident Insurance Company, Detroit, Mich.

Mr. President and Gentlemen of the Convention:

Your President has said that I would speak on industrial insurance; and that, of course, is what I would want to do, but it is almost impossible to speak of industrial insurance without mentioning liability insurance, which I think you are all more interested in directly and primarily than in industrial insurance.

I want to take advantage of a suggestion made by the President when he gave his address. The subject of insurance is so broad that in the short time which you would want to give your attention to my remarks, I would not be able to cover the whole subject; for that reason I will ask your indulgence while I read my few remarks that I believe will be of help to you, as follows:

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The prevention of accidents in shops is one of the most important things connected with our industrial system. That much has been done and is being done, is very evident to those who have observed the growth of industrialism during the past few years, and yet the time has not come, and certainly never will come, when accidents can be entirely eliminated. The human element enters too largely into all operations to make it possible to decrease the hazard very much. It is the experience of both liability and disability insurance companies that the hazard is increasing rather than decreasing in many lines of industrialism, and it seems to me that no discussion of remedies for this hazard, or the effects of shop accidents, is complete without a discussion of the bearing of insurance on the question, not only of liability insurance but disability insurance. Until recently most employers have differentiated the one from the other, being chiefly interested in liability insurance, without considering particularly the influence of disabilities and disability insurance on the liability premium.

It is not necessary, neither do I desire, to discuss liability insurance except to show that there is an upward tendency to liability premiums, the reason for this upward tendency, and how disability insurance affects it, and to point out to you how they may be combined for the mutual benefit of both the employer and the employee.

From the standpoint of the employer, the case has two phases, the egoistic and the altruistic, both of importance, although the egoistic phase seems, at first sight, to overshadow the other. It is generally considered that egoism is the chief motive in business. Undoubtedly it is, and should be. It is gratifying to know, however, that altruism is taking a more prominent place among the motives of many employers; and it can be safely said that if it cost nothing, but rather was profitable, it would have a much more prominent place in determining the action of those whose duty it is to see that the stockholders get a satisfactory dividend. I hope to point out where the interest of the employer and the employee are identical, and that each can benefit the other by co-operation, securing them a reduction in the

cost of and better insurance, both liability and disability, by such co-operation.

That the employer needs liability insurance is apparent. It is apparent also that the need for this insurance is increasing as time goes on. It has been and is being demonstrated every day that corporations, whether they be trusts or not, are in bad with the public.

A representative of a prominent liability company said to me while we were discussing the outlook of liability insurance, that the attitude of the legislatures, courts and juries is increasing the hazard of the liability companies; that while the limit for damages for an accidental death of an employe used to be $5,000.00, it had been recently raised to $7,500.00 and even as high as $10,000.00 in some states; that the sympathies of the public were becoming more and more pronounced in favor of the injured employee, and that the probabilities of damages being assessed were not only becoming more certain, but that the assessments were becoming larger, and that the employer who had been safe with a $5,000.00 liability policy would soon be forced to take a $10,000.00 policy at even a higher premium than is now being paid. This, he said was affected not only by the attitude of the legislatures, courts and juries, but also by the increased number of ambulance-chasers whose chief occupation, and in many cases only source of income, was running down people receiving injuries with the hope of pinning the responsibility on some corporation.

Referring to the matter of differentials established by accident insurance companies based upon conditions as they exist at various points, I would say that in Michigan where I live there is a reduction of seventy per cent. under the premium in Illinois. The employer in Illinois pays two and a half times as much for his liability insurance as he would have to pay in Michigan, because the legislature and courts and everybody else interested in Illinois have made conditions more difficult for the employer there, and have caused it to be more difficult for him to defend himself in a damage suit.

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That this condition exists is shown by the attitude of liability companies in establishing rates. I think it can be safely assumed that any reduction in cost of this protection to the employers is a thing greatly to be desired. Also if my friend of the liability company has sized up the situation properly, it is worth while for the employer to give his attention to anything which will tend to check the increase of the liability hazard, and consequently to keep the cost of liability premiums within a reasonable limit.

That disability insurance is growing in importance is becoming more apparent every year. In certain European countries disability insurance is made compulsory by law, the cost being assessed against both the employer and employee, except for that part which is paid out of the State Treasury. While such a law is not imminent in this country, conditions being different, yet it is a fact that attempts have been made in the legisatures of several states to enact such laws, the most prominent examples being Massachusetts and Illinois. While, as I said before, I do not think such laws are imminent in this country, yet they are possible, and these attempts indicate that the need of disability insurance is being very strongly felt. If there is danger of such laws being spread on the statute books, it behooves the employer to give the question attention with a view to guiding legislation in the right direction, or removing the need of such legislation.

Few realize the enormous cost to the people of the United States of disabilities, both sickness and accidental, suffered by wage-earners. The most carefully compiled statistics show that the cost of accidental disabilities is more than $500,000.00 per day, while the cost of sickness disabilities exceeds that amount by at least $100,000.00, so that the total cost approximates $1,200,000.00 per day. It is not probable that this cost can be reduced, and were it borne equally by all, would amount to practically nothing. It is the individual who suffers a disproportionate part of the loss, and whose loss is usually unexpected and unprovided for, who should be considered. It is he whose voice is heard loudest, whose case is and will be taken up by the legislators.

It is a notable fact that the average wage-earner, whether he be working with a pen or a shovel is improvident, and when disaster overtakes him it is a case of credit, privation or charity. Credit means debts difficult to pay; privation is even more undesirable, and charity is, or should be, still more repugnant to the mind of the American, whose chief pride is his independence and ability to take care of those dependent upon him. I do not mean to say that sayings are impossible, but that they are improbable, and that the cost of living has increased disproportionately to the increase in wages. If liability insurance is the only safe remedy for a possible and disastrous loss to the employer, so is disability insurance the only remedy for not only a possible but probable loss to the wage-earner, a loss which is even more disastrous than would assessed damages be to the employer.

It is probable that most employers have studied this question and have thought of all the things I have mentioned, together with many more. It is certain, however, that not being insurance men, and not being thoroughly conversant with the facts and figures which are not usually made public by the companies, they are not so well prepared to determine what the remedy is and how to apply it as are those who have made the subject a life study. I will, therefore, ask your indulgence while I state a few of the facts not generally known.

While liability insurance is very common, disability insurance is the exception rather than the rule. That this is true is due to several things. The disability company finds that under existing conditions, the expense-loading is entirely out of proportion to the benefits returned to the insured. This is not only observed by the insurance company, but also by the insured himself. It is a notable fact that for the premium which has become popular, that is $1.00 per month, the insurance company, after paying the fixed charges, cannot give the insured the kind of insurance or the quantity he wants. One of the secrets not usually published is, that to secure and hold the business the company must pay its representatives the whole of the first month's premium and twenty per cent. of succeeding months' premiums. Because of these charges it is impossible for the

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company to pay indemnities which equal, in reality, more than fifty per cent. of the wage-earner's pay. This is manifestly inadequate. It would be inadequate to take care of his ordinary expenses, and when you come to add the bills of the physician, surgeon and druggist, the insured finds himself wofully short of funds during the period of his disability. A careful compilation of many thousands of claims shows that if the doctor is paid all he charges, forty per cent. of the benefits paid for accidental liabilities, and seventy per cent. of the benefits paid for sickness liabilities, goes into the pocket of the doctor alone. These things are manifestly wrong. Disability insurance, which has been aptly called pay envelope insurance, should be conducted on an entirely different plan, and will be as soon as the employer sees where his true interest and duty lie. The man insuring his pay envelope expects, and is entitled to, the best return possible for his money. If any of it is diverted by an unnecessary condition of the business, he is entitled to have that condition removed, if it is possible to do so. But pay envelope insurance has not yet passed through the formative period. When it has, the insured will receive a better quality of protection.

Coming now to the interest which the employer has in the insurance of the pay envelopes of his employees, permit me to state a few facts which I believe are axiomatic. First, liability insurance is necessary. Second, the premium on liability insurance depends largely upon the frequency of accidents, the needs of the family of the injured employee, the animus of the employee toward the employer, and the number of ambulance-chasers contiguous to his plant.

Again, where the disabled employee has no insurance on his pay envelope, it is the custom in most plants to pass the hat, wherein the employer and the employees must drop something for the assistance of the disabled employee and his family, or must be embarrassed by a refusal to do so. This is expensive, not only in the money contributed, but the time lost in taking up the collection. Again, frequently the employer pays doctors' bills which are often burdensome items of expense.

These are things with which I know you are acquainted, and yet I wish to discuss two or three of them at a little greater length. First, the animus of the employee toward his employer depends upon several things. It can be safely said that his attitude toward his employer, after he receives his first visit from the ambulance-chaser, will be very different if he knows that he has a certain income sufficient to support his family during his disability than if he does not know which way to turn to supply their necessities. It is easy to imagine that a man when disabled will be in a much uglier frame of mind if he sees his dependents cold and hungry, than if they are warm and fed; that if he has no income he will not be so ready to blame his own carelessness for the accident as he will if his income is continued, even though in a diminished amount. It is safe also to say that he will be more favorably inclined to assume the responsibility of his accident if he knows that his doctor's bill is being taken care of, and that there is no bill piling up to be paid for out of his earnings. These statements are not theories; they are truths, demonstrated by actual experience. I shall not attempt to cite many cases, but will call your attention to one plant in which there are about 3,000 men employed, and in which disability insurance was carried by all of the employees. In 1907 there were about 500 disabling accidents reported and nine deaths. The liability company was not called on once. The employees and their beneficiaries were satisfied with the payments made by the company carrying the disability insurance, and the free medical attendance furnished.

Incidentally I will say, that because of the reduction of the hazard to the liability company, a very substantial reduction was made in the liability premium. I have this statement from the agent of the liability company, who said that this was brought about not only because no claims were made on the liability company for damages, but because they had no expense for first surgical aid and hospital treatment, and while the agent was reluctant to admit that the reduction was as great as $5,000.00, yet I was told by a person who did not wish his name used, that the reduction in the premium was a little better than $5,000.00.

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By co-operating with the employee and the disability insurance company, the employer and the employee can be of material assistance to each other. Because of the advantages accruing to the disability insurance company, from the fact that the business can be written more cheaply, the lapsation is not so great, and because agency and collection charges are not so high, it can afford to make very material concessions, concessions which are advantageous to both the employer and the employee. The benefits to the employer will come in the form of commissions for deducting the premiums from the pay-roll, and a reduction in the liability premium due to the fact that the disability insurance company will furnish medical and surgical aid free, and therefore enable the liability company to reduce the premium by the actual cost of such charges, a brokerage commission which can usually be saved, the elimination of hat-passing in the plant, a better satisfied body of employees, and last, but not least, because of the claim settlements made by the disability company will close the incident, so far as the liability company is concerned. From the altruistic standpoint, too, the employer has the satisfaction of knowing that his employees are not suffering want when disabled, whether they are disabled in the shop or out of it.

An enumeration of the benefits to the employee will take a little more time. As disability insurance is offered to the employee when solicited individually, it does not fill the bill. He is required to pay a policy fee of from $2.00 to $4.00. Based on the popular premium of $1.00 per month, the accident part of the policy covers about 50 per cent. of the pay enve'ope; the sickness part, however, because of the restrictions in it, pays for only about three-fifths of the disability, and if the benefits offered in the policy amount to only 50 per cent. of the pay envelope, then the actual benefit received will not exceed 15 per cent. or 20 per cent. of the pay envelope at the most. These restrictions in the ordinary sickness policy are the deduction of the first week of sickness, the elimination of benefits for all chronic diseases, the payment of benefits for the time confined to the house by sickness only, and the requirement that the policy must be in force for sixty days before sickness benefits will be paid. Adding the

additional expenses to which the employee is put for doctor's bills, very little is left for the payment of the grocer and coal man. By the co-operation of the employer, the insurance company can afford to give the employee very much better insurance. First, it can afford to throw off the policy fee entirely; it can afford to furnish free medical and surgical attendance; it can afford to reduce the sixty day period before sickness benefits are paid to thirty days; it can afford to pay for all chronic diseases; it can afford to pay for the first week in serious cases of illness, say where the disability lasts thirty days or more; and particularly in the case of foundry employees, it can afford to raise the manual benefits for accidents fifty per cent., that is, the molder pouring hot metal, according to the present rates, is entitled to $20.00 per month accident benefits and $30.00 per month sickness benefits, for $1.00. Under the plan proposed, the insurance company can afford to pay him $30.00 per month for both accidental and sickness disabilities. And it can afford to increase the benefits mentioned in the policy very materially, particularly if the employer is charitably disposed. The employer is usually allowed fifteen per cent. for deducting the premiums from the pay roll, and if he is satisfied with a smaller percentage, say five per cent., giving the insurance company the other ten per cent., the insurance company can afford a very material increase in the benefits. To illustrate: Under this arrangement, a machinist who is entitled to $40.00 per month for both accident and sickness, and $400.00 for accidental death, for $1.00 per month manual rate, would be entitled to $50.00 per month and $500.00 accidental death, provided the employer throws off ten per cent. from the commission allowed for making the collection; and $55.00 per month and $550.00 accidental death, provided the employer makes the premium collections for nothing. It is needless to say that this is only one of several propositions which might be secured by the employer for the employee, although this seems to be the most popular one.

What the insurance company would require of the employer is the privilege of soliciting the business in the plant. As a rule, the employer is reluctant to permit the solicitors of an insurance company to solicit the men when they are busy. But are they

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justified in taking that stand? It does not take as much time to solicit the insurance once as it does to pass the hat a few times, and when the men are insured, or have had a good insurance proposition offered them, the employer is justified in refusing to let the hat be passed, saving himself and employees both time and money.

Numerous employers have adopted a plan similar to the one outlined, have taken the full collection commission and established a fund for the voluntary payment of a burial benefit of $100.00, to be paid whether the insured meets death accidentally or from natural causes.

It might be argued that the employer is receiving benefit for this concession out of proportion to the benefits paid the employee. If, however, we consider that less than one-sixth of the disabilities, both sickness and accident, paid for under the policy, occurs in the plant, that argument falls flat.

Regarding what is commonly called shop insurance, that is, beneficial associations organized and conducted by the employees themselves, permit me to say that this form of insurance has no advantages over that offered by the insurance companies, and has many disadvantages. For example, the usual premium collected is ten cents per week; the usual benefits are $5.00 per week, with nothing paid for the first week. It costs the employer as much to deduct these premiums as it will to deduct the premiums of the insurance company. An analysis of the two plans will show that not as much insurance is given for the premium as is given by the insurance company. The insurance is inadequate. Five dollars per week will hardly pay the doctor's bill, let alone the bills of the grocer, the coal man, the landlord and others. Ten cents per week is $5.20 per year. Under the same conditions, for about double that premium in most cases, the insurance company can pay two and one-half times the benefits, to say nothing about free medical and surgical treatment, which brings the benefits up to from three to three and one-half times that paid by the shop association.

This may appear to you to be paradoxical. It may be said, "How can this be possible, when the shop association is conducted at a minimum expense?" I will ask you to consider that these associations are usually conducted by men who are not business men, whose occupations bar them from giving the business the close attention necessary to the successful conduct of any business. I have had much experience with associations of this kind, and can confidently say that most of them fail unless the employer contributes to their support. This is true because of poor management, because the insurance is inadequate, and because of jealousies growing out of real or fancied discrimination in claim payments.

Neither do any of the benefits accrue to which the employer is entitled, if he handles the insurance matter himself, securing better protection for his employees than they can possibly get for themselves by whatever plan is adopted.

Finally, I desire to say that while it was not my intention to advertise my business, except that a fuller comprehension of the subject by you would assist the companies writing disability insurance, I will say that I shall not consider it an imposition on my good nature if you ask for a more detailed statement of the insurance which can be secured by you as an employer for your employees.

PRESIDENT ANTHES: It has grown so late that we will defer the report of the Committee on the Industrial Education until tomorrow morning. I will appoint Mr. I. S. Seaman, of Pittsburg, as the convener of the Committee on Nominations. I want to remind you that the reception which is to be accorded the visiting delegates will be held this evening at the Sinton Hotel at about eight o'clock. We want you all to go and tell your friends. We would like to have as many there as possible. It will be what is called a "get together" gathering. The officers of the Association will be there, will extend the glad hand, and make everybody feel as much at home as possible.

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I will state that the accounts of last year have been gone over by a firm of chartered accountants, who confirm the report as submitted by your Secretary-Treasurer.

Meeting adjourned.

AMERICAN FOUNDRYMEN'S ASSOCIATION.

Statement of Receipts and Disbursements covering a period of 13 months from June 1, 1907 to June 30, 1908.

RECEIPTS.

Dues for 1907-1908	$2,280.25
Balance from 1906-1907	635.94

DISBURSEMENTS.

Stenographer taking proceedings at Convention	$ 64.56		
Printing proceedings of Convention	219.52		
Stationery	11.75		
Printing Reviews of Convention	134.30		
Illustrations and Cuts	14.50		
Copies of Reviews	52.50		
Circulars	4.75	$501.88	
Printing		260.43	
Postage		439.00	
Salaries		1,457.05	
Sundries		14.18	
Committee and Current Expenses		205.91	
Balance on hand		37.74	
		$2,916.19	$2,916.19

JENKINS & HARDY,
Chartered Accountants and Estate Agents,

Toronto, Canada.
May 15, 1909.

To the American Foundrymen's Association.

We certify we have audited the books and vouchers of the American Foundrymen's Association, covering a period of thirteen months from June 1st, 1907 to June 30th, 1908. The annexed statement of Receipts and Disbursements truly sets forth the affairs as shown by the books.

JENKINS & HARDY,
Public Accountants.

RECEPTION BY THE CINCINNATI COMMITTEE.

The reception of the evening was a very brilliant and enjoyable affair. The Committee of Entertainment had spared no trouble and expense in making every one welcome. It was a thoroughly well managed "get-together" gathering, for which the Committee received the hearty thanks of every one present.

An informal collation, gotten up in magnificent style, and showing the capabilities of the hotel cuisine, formed so drawing an attraction, that even dancing was neglected for the time being.

Our members will long remember the cordial hospitality of Cincinnati as shown by the kindness received all along the line while in that beautiful city.

SECOND SESSION—WEDNESDAY MORNING, MAY 19.

PRESIDENT ANTHES: The first order will be the deferred report of the Committee on Industrial Education, Mr.

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Paul Kreutzpointner, Chairman. Mr. Kreutzpointner is here, and he is going to give us a short talk which he will illustrate by diagram. I trust he will have close attention; he is a man who is very well versed in the subject; he has put a great deal of time into this work, and I can assure you that anything that he has to say will be worth hearing. (Applause.)

REPORT OF COMMITTEE ON INDUSTRIAL EDUCATION.

(See Page 5 of the Transactions.)

MR. PAUL KREUTZPOINTNER: Mr. President and Gentlemen, it is now generally recognized in this country that some adequate provision should be made for the more general introduction into our educational system of industrial education; and the question now before us is how best can that be accomplished. Last Monday I had the pleasure of an interview with Mr. Dyer, the Superintendent of Schools in this city of Cincinnati. I was informed that tomorrow at a meeting of the School Board a plan would be brought before them which will introduce industrial education into the schools of Cincinnati. I was accorded two hours and a half of the valuable time of the Superintendent, and we talked over the question. Two points came up for discussion, of which is the better way to educate the masses:—In this country one of two plans will have to be adopted. At the present time there is an almost universal desire to introduce European methods looking to industrial education. On the other hand we must prepare our own people according to the principles of our country; we cannot introduce European methods so far as they are based on centralized power of government. Ours is a democratic form of government, and we are also lacking in power to levy taxes to the extent that they do over there. Moreover, we have to deal with the institution of democracy and social freedom, which does not prevail over there. We have first to look out for the economic side of the question. During my interview with Mr. Dyer, when these points were

touched upon, I also said to him that I was willing to go with him to any of the largest establishments in Cincinnati or in any other city of the United States, and prove that thousands of dollars worth of material and labor is being wasted every year, not wilfully, not viciously, but because of the lack of education on economic and equitable lines as to proper methods of work done there. I said to Mr. Dyer, "Without fear of contradiction, I can step into any establishment and in an hour prove that statement." That is one of the problems; the other problem is, how to entrust power and confer social status in such a way that we do not stifle the proper pride and independent spirit of young men, and that we shall rather stimulate them to take one forward step after the other up the ladder of progress and ambitious effort. These are the problems that we have to solve. Your Committee on Education recognized that they had before them a serious problem worthy of their best efforts. Let me quote from an address delivered before the National Education Association by Mr. Andrew Draper, Commissioner of Education of the State of New York, in which he says:

"There would be quite as much of this as we could afford if the educational system did not lead so exclusively to professional employments and to the quasi-professional po itions and the managing positions in the business and industrial avocations. As it is there is so much of it that it is actually making us poor."

"Any hand work that is found in the elementary school—and on the whole it is very little—is sustained on the theory that it is a desirable employment, an intellectual quickener, rather than that all the world must work, and that work with the hands must be much more common and quite as reputable as work with the head. Instead of leading to a trade it prepares for the manual training school, if there is one, and that leads to a technical college, if it leads anywhere, and that to one of the engineering professions. Nothing in the common schools leads to a trade."

"It is a fact that our unskilled labor does not come out of our schools, joined to the fact that the unskilled labor that we have is so largely trained not in the schools but in a very haphazard

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way in the shops, that is disturbing the equilibrium of our factories, impeding our industrial productivity, and raising so much criticism upon the unbalanced curriculum of the schools."

"From the bottom to the top of the school system the eye is on the school above, and the school above leads to a professional or a managing employment rather than to a trade vocation."

Now that is the situation, gentlemen; and the question now is, what can the Committee on Industrial Education of the American Foundrymen's Asssociation do to enlist the interest of our industry in such ways and means as will meet the necessities of the case.

Only the other day the Supervisor of Manual Training at Altoona told me that boys that had passed through the local parochial school and who had not that preparatory training and preparation for his work in the manual training school possessed by the other boys who had come from the public schools were never able to regain the ground lost because of that lack of preparation.

At Wanamaker's large stores in Philadelphia and New York they have established a school where their clerks are trained to a realization of the knowledge why there is a difference of twenty cents in a pair of gloves, or in this, that or the other article, so that they are better able to explain to their customers why an article costs more, why another article is cheaper in price. The relation of the work done by the man at the bench, or wherever he is employed, to the welfare and general prosperity and life of the country and its people should be taught in our schools as well as skill in hand.

Mr. Kreutzpointner showed a diagram of a plan for education in industrial training projected for the schools of Cincinnati, to be arranged under a graded system of vocational instruction; and gave notice that he intended to introduce a resolution endorsing the movement on foot in Cincinnati, believing that such

endorsement would come as a gracious act on the part of the Association in the very beginning of its convention in the city of Cincinnati, as well as being a move in the direction of encouraging what the Association stands for.

The resolution above referred to was at the request of Mr. Kreutzpointner read to the convention, and its adoption moved by Secretary Moldenke, as follows:

RESOLVED: That the American Foundrymen's Association endorse the proposed plan now before the school authorities of Cincinnati, of introducing industrial and trade education into the public schools. At the same time the belief is expressed that a liberal share of attention be directed to the technical and economic subjects of industrial education.

The question being taken on the adoption of the above, it carried unanimously. Since the Convention the following was received:—

MEMORANDUM FROM THE COMMITTEE ON INDUSTRIAL EDUCATION.

As indicated elsewhere in the Proceedings a resolution was passed by the Convention to endorse the proposed new school plan for the Cincinnati schools whereby a four years' course, or trade school course for boys, is to be made a part of the school system of Cincinnati. For those pupils of the public elementary schools who expect to enter this trade course for one, two, three or four years, the seventh and eight grade classes are used as a preparatory, or industrial, school. Thus, this four years' trade school will be a continuation of the elementary school, beginning with the primary grade. For those pupils who expect to enter the high school, or those who neither expect to go to the high school, nor to the trade school, the seventh and eighth grades remain as heretofore, with the manual training and domestic science instruction undisturbed, as indicated in the diagram of the plan given herewith. Such, or a similar plan should be advocated for every city.

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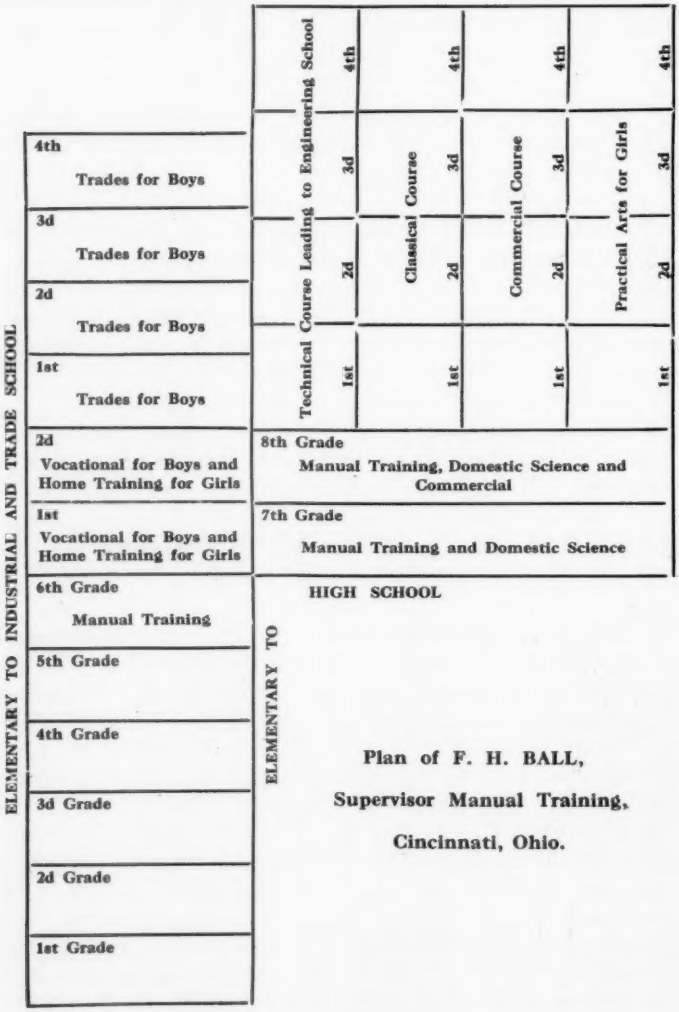

Plan of F. H. BALL,

Supervisor Manual Training,

Cincinnati, Ohio.

PRESIDENT ANTHES: As Secretary Moldenke has explained you cannot have the pleasure of hearing this morning those papers that were to have been illustrated by moving pictures; and therefore, the first paper to be presented will be that by Mr. J. S. Whitehouse, on "The Side Blow Converter for Steel Castings, and Its Operation." (See Page 69 of Transactions.)

DISCUSSION ON SIDE BLOW CONVERTER FOR STEEL CASTINGS.

PRESIDENT ANTHES: We would like to bring out as much discussion of this paper as possible. Has any one any questions to ask?

A MEMBER: I should like to ask in what manner Mr. Whitehouse adds scrap to the blow?

MR. WHITEHOUSE: When the flames show an indication that the blow is getting very hot the man throws scrap into the top of the converter.

A MEMBER: Simply in a raw condition?

MR. WHITEHOUSE: Small, such as he can handle, into the top of the converter till the blast cools down.

MR. SMITH, Toledo: Do you preheat the scrap before adding?

MR. WHITEHOUSE: No, simply add cold.

MR. HAMILTON, Newport News: With what pressure do you blow?

MR. WHITEHOUSE: It will average about two and a quarter to two and a half pounds.

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MR. HAMILTON: Did I understand that you put steel scrap into the converter within the duration of the blow?

MR. WHITEHOUSE: In some blows, yes, sir.

MR. HAMILTON: After you get the silicon light?

MR. WHITEHOUSE: Yes.

MR. BROWN, Alliance, O.: Is it possible to make various carbons?

MR. WHITEHOUSE: Yes, you can vary the carbon by your final additions. It is usual and customary to blow the heat down till the flame drops, which is about one-tenth of one per cent. carbon; and then the carbon is raised by the addition of either melted pig iron or pulverized coke. It is possible to go as high as you wish in carbon. If you want higher than 40 or 50 points you can stop the blow before completion.

MR. BEESON, Youngstown: What would be the objection to blowing down and recarbonizing with manganese or spiegeleisen?

MR. WHITEHOUSE: It is the custom to blow down to say about nine or ten carbon; then you recarbonize with ferro-manganese, melted pig iron and spiegeleisen. I usually use coke. If you melt the ferro-manganese in a small cupola as has been done down back East your loss is very heavy. I think the most economical way of doing it is throwing it into the converter at the end of the blow.

A MEMBER: The same principle as followed out in the ordinary converter steel process; they use ferro-manganese in the converter direct; where they are using spiegeleisen they melt it in a small cupola.

MR. WHITEHOUSE: In the small converter practice the usual custom is to add ferro-manganese, and then pig iron.

MR. KNIGHT: How many blows do you get out of the converter with one lining, and where does the blast enter?

MR. WHITEHOUSE: As to the number of blows out of a lining, that is a question that is hard to answer. My practice is never to reline entirely. At the end of the heat day your converter is cooled off and is patched up and then dried out, and ready for the day after. In some plants it is customary to line up and blow till the converter is cut out, then knock the lining out and reline; which I think is not good practice, because when the converter is cut out badly there is a great loss of iron.

To your second question, the practice is usually to blow just at the surface; the tuyeres impinge slightly upon the metal. Of course, during the blow the tuyeres would really be submerged; in fact, they actually are. If you suddenly stop your pressure you will find that your metal will run back in the wind box.

A MEMBER: About what angle do the blowers impinge on the surface of the metal?

MR. WHITEHOUSE: I cannot say; it is very slight. They usually use an indicator on the converter which will circle off into degrees; and it is customary good practice to blow from about five to nine degrees.

MR. HAMILTON: I would like to ask Mr. Whitehouse if he has a top set of tuyeres?

MR. WHITEHOUSE: No.

MR. HAMILTON: Did you ever have them?

MR. WHITEHOUSE: When I first started to blow we had top tuyeres; we discarded them about eight years ago. You get more than sufficient blast from the lower tuyeres.

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MR. A. S. BRAUGHTON, Medina, N, Y.: I would like to know if it is not possible for us to hear what is going on. We have been bothered with the continuous roar of the machinery below, and the still voice of the gentlemen who read papers and of those who ask questions in the discussions. We are here to acquire some knowledge in these matters; and I believe that it is only due us that these papers shall be read in a loud tone of voice and the questions asked in the same tone so that we can get this knowledge and this information. It is of great moment for us to use our time to advantage here and not to go away without having heard what these gentlemen have to give us. I believe that we can in some way stop the noise by closing off the doors, and then requesting the gentlemen who are to speak to us and ask questions to use a louder tone of voice, so we can take it in. I for one wish to have it. (Applause.)

PRESIDENT ANTHES: The last gentleman's remarks are very well taken. As far as the noise down-stairs is concerned, we have tried to do all we could, it seems we cannot close it off altogether; it is almost apparent that we may have to close off the whole outfit down-stairs if we are to get any benefit up-stairs here. I will ask the gentlemen reading papers to make the best effort they can and the gentlemen who are asking questions to call out their names so that the stenographers can get them. They will save time and make it easier for the men who are trying to keep a record of what we are saying. We want to get a record of everything that goes on here. Many important points are brought out by discussion, and some few words may be lost which would illustrate the whole argument, and because of the want of which when you read over these discussions you will say it is not what you said or what you meant. You have nobody but yourself to blame very often for that. I would like very much to have you ask your questions in as loud a tone of voice as possible.

DR. MOLDENKE: I would like to add that we should like to have had these meetings further away from the exhibitions, on account of the noise; but our experience has been that we have to be near where the crowd is if we want to have any

meeting at all. If everybody will speak out loud, as the President suggests to you, it will help matters.

A MEMBER: I should like to ask Mr. Whitehouse if he has any difficulty in pouring a heat hot with bull ladles when he is using only one and a quarter per cent. silicon in his cupola charge?

MR. WHITEHOUSE: Why, at the present time we do not make a practice of pouring small bull ladles, although I did so up at Everett, and we had no trouble pouring the iron hot. We pour a heat that runs only one per cent. silicon without any trouble. At the present time we pour whole heats of castings weighing less than thirty pounds with a thousand-pound ladle, without spilling the metal.

PROFESSOR STOUGHTON: I suppose the discussion is closed. I want to thank Mr. Whitehouse for the frankness that he has exhibited in giving us this information. I am sure it will be valuable to all who are interested. It is not usual for us to get so much and so frank information from those who read papers. (Applause.)

PRESIDENT ANTHES: The next paper on our program is on "Open Hearth Methods for Steel Castings," by Mr. W. M. Carr.

DR. MOLDENKE: Mr. Carr has written his paper more particularly on the production of an open hearth furnace which will take small charges. That is something which the foundry has been looking for as well as the converter process. He tells me that he has made an open hearth furnace which will make steel in charges of 500 lbs. He uses oil and regenerates the air with his regenerators outside; so you will find his paper quite interesting. A few weeks ago I made it my business to go to Niagara Falls and attend a meeting of the Electro-Chemical Society, of which I am a member, in order to find out what they have done in the way of melting by electricity. Doubtless Professor Stoughton will give you something on that subject this afternoon. Those who are experimenting in Europe I believe have

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now some seventy-five odd furnaces for making steel electrically. The tendency, as I saw it, appears to be to put these plants where they have water power, and to go away outside of civilization to make steel as a consequence. It is very nice to know that we can make steel at $16 a ton in an out-of-the-way place; but it is not in line with the conditions that we meet in our own country. We need a very large steel casting plant as a separate establishment, or a little steel plant as an annex to a big foundry. It struck me that the solution of the question would seem to lie in our taking steel charges, steel scrap castings if you like, or specially made billet steel, made in the cheap ways of everyday steel practice, bringing it to the melting point in the cheapest way that we now have, and then putting it into an electrical furnace, melting and giving the finishing up treatment by high priced current and getting the most magnificent refining that is possible that way.

I told the gentlemen present at the Niagara Falls meeting to just forget for the moment the reduction from the ore, and go back to the actual problem and see if it was not possible for the foundrymen to run all day on castings and then put the whole power on at night to make small heats of high class steel, and that in that way you would get it down to a commercial basis much quicker than it now appears to be going. I believe that they seemed to be sufficiently interested to think about that a little. Certainly you can make fine castings by the electric process; but it is still too expensive unless you can get about nine-tenths of it done by a cheap way and then the last tenth of it only by electricity. I know there are five or six hundred foundries just waiting for the opportunity to make small castings in a small way.

Perhaps Professor Stoughton can give us a little bit this afternoon on the subject; but in the meantime if something can be said now I suppose we will be glad to hear it.

PRESIDENT ANTHES: This subject is open for discussion. We will consider the paper as read, and it will appear in the Transactions. We will be glad to hear from anybody.

MR. WHITEHOUSE: I do not know whether the Doctor can answer my question; but what will be the approximate cost per 1,000 lbs.?

DR. MOLDENKE: I cannot say absolutely what that is; but I did find out this that Major Stassano, of Italy, made steel castings direct from the ore (with power at about what it would cost us here) at a cost of five cents a pound. I told him that this would not do here. Now if he had taken ordinary Bessemer steel at say nine-tenths of a cent a pound, then he might have had a cost of his steel castings of two and a half or three cents a pound. They have got pig iron down to $14 to $16 a ton electrically. They can make it that cheap if properly located. The question of water power for current is a little bit illusive. We think we have to go to natural water-falls. You might erect a big producer plant and use, if you like, coal full of sulphur. I know cases where they have a five or six foot vein of coal unfit for other purposes and could take a gas engine and make current very cheaply at the mine and transmit the current. In other words in going into this kind of work we must think of a whole lot of things. We do not necessarily have to put our plants in Northern Canada or Mexico where they have cheap water power; but we can put them where they have cheap coal and make current as cheaply as at Niagara Falls. Any plant that has 300 or 400 h. p. for its day load, during the night might have that horse power employed making current for the electric steel process. So the method is within reach without going to waterfalls away from the markets.

MR. T. J. BEST, Montreal, Can.: I would like to find out the possible cost of a small furnace for melting say from five hundred to a thousand pounds of steel in a charge? I have been trying to find that out for a long time past. I was connected with a little concern over in Canada that spent a large sum and the plant is for sale today. It has a ten ton open hearth basic furnace, well equipped in every way. We have not been successful on the lines we started out on because we could not produce steel for lack of business. We expect, however, that business will again spring up and perhaps we will be able to manu-

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facture steel and put it on the market; but if we could manage to get a small furnace of from 500 to 1,000 lbs. at a charge I can get ten cents a pound for all I can produce of light castings. I mean for castings running all the way from say four ounces to 100 lbs. Of course steel castings usually run from 40 to 50 lbs. up to ten tons or more; but I am speaking of very light castings for light machinery. It seems almost impossible to do it; yet I have been told that it can be produced all right; but I have not seen it done. We have tried and it has been a failure so far.

PRESIDENT ANTHES: Is there any one here that would like to answer Mr. Best's question? It is one that is important to the man who wishes to manufacture, as he does; and I am sure he would appreciate any information given him.

MR. GIBENEY: This question of a small furnace for making small castings is one of more than passing interest to our railway. Some years ago they went to great expense in erecting a cast iron foundry for making car wheels so as to have more room for making other castings where they were. It is because of the defects of cast iron car wheels that the steel wheel is replacing it. The question is up to us right now as to employing part of this equipment to manufacture small steel castings as well as malleable castings. I was in hopes that Mr. Carr would be here to give us some additional information to that contained in his paper on this very important question.

DR. MOLDENKE: I think I can say that Mr. Carr got up his little furnace first when making experiments with a special steel process. He went through with it and got some very fine results. He melts with oil and regenerates the air. His address is No. 120 Liberty Street, New York City. You can write to him any time, and he will be glad to give you any information on this subject.

PRESIDENT ANTHES: If there is no further discussion on Mr. Carr's paper we will have next the paper on "Notes on Air Furnace Construction for Malleable Castings," by Mr. W. H. Kane.

DR. MOLDENKE: Mr. Kane's paper is a description of little kinks and practical points in building, and incidentally complete plans for an "Air Furnace." You seldom get hold of a plan like that. They generally take the dimensions out before they take a photograph of the design; in this case the dimensions are all on. If you take a little magnifying glass you will be able to read them. The paper is of special importance to the malleble man.

PRESIDENT ANTHES: Mr. Richard K. Meade now has a paper on "The Use of Pulverized Coal for Foundry Purposes."

DR. MOLDENKE: Mr. Meade is not here today. I asked him to give us some information as to the use of pulverized coal for foundries. He did so, and you will find copies of the paper here for distribution. It is a very interesting paper. Experiments were made in pulverizing coal and burning it in malleable annealing ovens. The thing that has puzzled me was where they left the ash; but they tell me the ash dissappears; somebody gets it. Perhaps the people in the neighborhood get it through their windows. But as a matter of fact the ash goes up so finely pulverized that it goes through the stack. Combined with the minimum amount of air they say they get some very economical results from the combustion. This is all well described in the paper in question.

MR. HALL: I would like to ask if anything has ever been done regarding the use of pulverized coal in the cupola?

DR. MOLDENKE: Nothing done in that line so far as I know. Experiments have been made with oil in the cupola by a concern in Germany. I do not know how successful they have been. They are melting iron without any solid fuel at all. Experience would lead one to infer that unless they heat the air that they blow in there they are not going to meet with success. The question came up the other day about one of those melting furnaces that you see outside making steel castings. About the time of the Milwaukee convention I was down at one of the

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plants in Chicago that is trying to make malleable castings by the use of oil. In this oil furnace I found that it took about an hour to melt 1,000 lbs. of iron, or about half an hour too long. It led me to believe that the solution of their trouble would be found in regenerating the air that blows in the oil, in other words, imitating an open hearth furnace. You will thus get air at 700 or 1,000 degrees F. and will be able to melt the iron quickly. The next few years may show something in this line, I cannot say just how, but as we study the use of coal to get quick combustion at high temperature for our results, we get some very good information. So I rather think there will be some development coming in that line.

PRESIDENT ANTHES: The next paper is by Mr. George Muntz, "Machine Molding vs. Hand Molding."

Paper was read by Mr. Muntz, (see page 105 of Transactions.)

There being no discussion on this paper, the meeting adjourned.

THIRD SESSION—WEDNESDAY AFTERNOON, MAY 19.

PRESIDENT ANTHES: Trouble has arisen with the Board of Underwriters, who promised to do all sorts of things for us, and through some mismanagement on their part, or willfulness, we are blocked in our actions in regard to moving pictures after they had promised to do what they could. However, I believe the stereopticon pictures can be given, and possibly after the people in the Underwriters' office wake up we can show the balance.

The first paper on the program will be on "The Cost of Steel Melting in Foundries," by Professor Bradley Stoughton.

PROFESSOR STOUGHTON: The object of this paper is not so much to illustrate as it is to study the question as to where, if anywhere, or under what conditions, if any, electric steel melting may come into foundries for the production of steel castings.

The electric steel making process is now coming into a position where I think foundrymen view it with a great deal of interest. There is in Europe at least one steel foundry using the electric process. There are many ingot plants using the electric process, and the electric steel making process in Europe has already come into a position of some importance.

There are also several steel making plants in this country using electricity, and there are several more furnaces already bought and paid for, and about to be installed, although so far as I know none of these are projected for foundries at the present time.

Now I just want to discuss as well as I can some of the costs, in order to see whether the electric process can compete with any of the present processes on a commercial scale. I want to say in introducing the subject that I have not any connection with any electric process, and that I have no interest in this matter itself in a commercial way but merely as a matter of educational interest. I want to take up the processes in the order of their importance as judged from the standpoint of production.

Professor Stoughton then read his paper and illustrated it by reference to large charts made from the tables contained therein.

(See earlier in the Volume for this paper.)

DISCUSSION ON PROFESSOR STOUGHTON'S PAPER.

PROFESSOR STOUGHTON: These costs are not expected to satisfy anybody. I have not entertained the hope that they

would satisfy anybody; but they will give a general idea of the position that the electric furnace should occupy in the future. You may be interested in the cost of installation of these electric furnaces. I will say that a one ton furnace can be bought for $5,000.00, a two ton furnace for $14,000.00 and some odd hundred; a seventy-five ton furnace I am not able to give the price on it, but it is many thousands of dollars. I do not care to recommend any of these furnaces specially; but among the prominent types are the induction furnace, the Stassano furnace that Dr. Moldenke spoke of this morning, the Herault furnace, the Gin furnace, etc.

I will say just one more word, which was suggested by Dr. Moldenke this morning; namely that the furnaces of the United States Steel Corporation are making electric steel in this way. They manufacture steel first in the Bessemer converter, and get a steel running up so high in phosphorus and sulphur, as not to be readily salable. This product from the Bessemer converter is poured into the electric furnace. There it is de-sulphurized and de-phosphorized; and the cost of this in the electric furnace is under $3.00 a ton; so that if a foundry were to put in a double installation of either an open hearth or converter furnace, and then super-heat in an electric furnace to get rid of the phosphorus and sulphur they will get all the advantages that the electric furnace can give at one cent per kilowatt hour. The cost of this electric treatment will be a little less than $3.00 a ton, which is to be added to the cost of the steel making in the first instance.

MR. JAMESON, Bradford, Conn.: I notice that there is a difference of $9.15 between each of the different costs in the electric process. Subtract that from the cost at one cent per kilowatt hour it leaves about $19.65 for operating cost exclusive of the cost of the current. May I ask what that cost represents?

PROFESSOR STOUGHTON: $11.81 of that $19.65 represents metal; the other seven dollars and some odd cents represents labor, lining for the furnace, etc.

MR. JAMESON: The wear of the electrodes, and all that sort of thing?

PROFESSOR STOUGHTON: The wear of the electrodes is included, yes.

MR. FOGARTY: Does that cost by electric furnace include the total cost from melting cold material to the finished steel?

PROFESSOR STOUGHTON: It includes the cost of the cold material to the finished steel.

MR. FOGARTY: Would it be possible to melt in the cupola and then refine the pig iron with the electric process?

PROFESSOR STOUGHTON: Your idea would be to melt the pig iron in the cupola and then turn it out into the electric furnace and refine it there. That can be done in the larger sizes, but the cost of installation in those sizes is very great. The other operating cost would be less than given here, but not very much less. I would not care to enter into the names of the different furnaces, because that can be found out from the makers; and I wish particularly to avoid any idea of advertising any furnace, I have not any such object.

MR. KNIGHT, Chester, Pa.: What is included under operating cost? Does that include such fixed costs as insurance, interest on the investment, depreciation, etc.?

PROFESSOR STOUGHTON: The operating costs do not include over-head charges of the plant, or selling costs, the general works cost, such as office costs at the plant; it does include repairs, depreciation and interest on the investment. It does not include taxes and insurance.

PRESIDENT ANTHES: If there is no further discussion we will go on with the rest of the program. Mr. Hawkins will

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now give his paper on "The Heart of the Foundry, as seen by the Foundry Engineer."

(See previous part of Volume for this paper.)

The paper was copiously illustrated by lantern slides.

PRESIDENT ANTHES: We will now have a paper on "Continuous Melting in the Foundry of the Westinghouse Air Brake Company," by Mr. S. D. Sleeth. I may say that I personally went down to see Mr. Sleeth, and he demonstrated to me what they were doing in the Westinghouse plant. I was so impressed with what they were accomplishing there that we prevailed on Mr. Sleeth to give us a paper. I can assure you that it ought to be a very interesting paper on continuous pouring.

(See page 13 of Transactions.)

DISCUSSION ON MR. SLEETH'S PAPER.

MR. S. D. SLEETH, WESTINGHOUSE AIR BRAKE COMPANY, Wilmerding, Pa.: There was something in Mr. Hawkins' article as to his melting ratio being eight to one about. It did not strike me at first, but I see now why it was that he had a small heat. We are running anywhere from 200 tons to 180 tons, night and day, 11 pounds of iron to 1 pound coke. That is on account of the large heat, because your bed is divided over so much more metal. I just noticed in his paper that he only melted eight to one. That would account for it.

I did not go into this paper very elaborately, because although at first it was a very hard thing now it is simple to run continuously. When we first started it, we did not know of any person that had melted that way, and we just had to work it out ourselves. We worked it out by seeing how slowly we could

melt. We found that a low blast pressure melts better than a high, that is about 11 ounces; and we do not hold any metal in the cupola worth speaking of, so we keep our tuyeres very low. Early in the morning, before the hour when our molding machines get started we are ready to tap, in fact almost immediately after the whistle blows. The iron is all ready to be poured, and then after about an hour some of the machine molds come up, we have to melt much faster, and then slow up for a while again. If it is a small heat we have to put in more coke. If it is large and we want to melt faster, we put in less.

If any of you read the paper you will see why we hold it over the dinner hour. I might say that we have held a cupola some times as high as two hours. When we first started the continuous process, it was new and we had a great deal of trouble with the conveyors breaking, which would hold us up some times as much as two hours. I do not know that I can say anything more just at present. If any one wants to ask questions or if I can give you any information I will gladly do it.

PRESIDENT ANTHES: Mr. Sleeth has touched upon a few of the important points in his paper, upon which we count on getting a good discussion. As I said to you yesterday, the great problem which the molding machine men have to contend with now is how to handle molds quickly enough and economically enough to work the molding machine to its utmost capacity. In the Westinghouse establishment where they are using this continuous pouring system they are making their large molds by mach nery.

I think that Mr. Sleeth's paper ought to bring out a good discussion, because one of our serious problems now, where we want to get out the greatest production at the smallest cost, is to do away with hand-molding and the handling of molds. Mr. Sleeth can tell you how they handle their molds while pouring. I hope this will bring out a full discussion.

MR. MUELLER, Decatur, Ill.: I would like to ask, does that apply mainly to iron, or is it brass and iron?

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MR. SLEETH: All iron. We have a brass foundry but this is iron that we are now speaking of.

MR. MUELLER: You can use the same conveying system with brass, can you not?

MR. SLEETH: In handling molds I do not think brass would be as easy as iron, because you must be more careful in pouring brass than iron; but we have machines, and convey the sand by an over-head conveyor to the molding machines in both brass and iron. We use what we call a reciprocating conveyor. But we are putting in a new table where it will be carried on a belt up to the first machine, and then out of it among the other machines by the reciprocating conveyor.

MR. MUELLER: You would not have the same trouble with the iron as in brass? We spent about $10,000 or more in a conveying system, and after running it two weeks it was almost worn out. We thought it was the fault of the sand; but on the other hand the machinery was so constructed as to practically cut out on the bearings, and we saw that it was only a matter of a short time until it would have taken all our time repairing it, and would be more of a waste than a gain. But we are still figuring with it. We are figuring on a belt conveying device, and thought of making first a sample 25 feet span for a test. The parties that are figuring on it for us have guaranteed that if we would put the installation up and use it, they will furnish the material. It is a conveying concern that is just as anxious to get results as we are—although we are more anxious. If we could find out some one that has done experimenting we would like their advice before we go into it; but if we do get a-going we are perfectly willing to give to anybody that will write to us, or probably at the next meeting, our experience in conveying and handling sand, sifting sand, etc. One of the important features would be the handling of the molds faster.

MR. SLEETH: I might describe how we handle what we call our No. 2 table for No. 2 work. On that table there are castings a great many of them only measuring a few inches.

Notwithstanding the small size of the castings we were running 52 tons off that table alone on a ten hours' run, showing what a great amount of metal can be used up under the continuous process in pouring small castings. We move the table at the rate of 20 feet per minute. A drag is put on. There are cores in it. As it passes on up the core-setters set the cores. Then the cope s put on. It goes from that around the curve to the casters in front of the cupola, which is connected with an endless control system. The casters have a ladle that can be raised or lowered by hand. They step on the table and travel with it, pouring anywhere from two molds to a half dozen, or a dozen; and by the time they are poured off, they are off at that end and they can ride back to the cupola. They do that all day long. The table is not supposed to stop, but just goes right straight ahead. It moves at the rate of about 21 feet a minute, which allows them to core up, cast, cover down, and all.

MR. MUELLER: They do not use the platform, they walk with it?

MR. SLEETH: They walk with it. They get very expert. In some molds we put in eight cores and two or three anchors at the same time, and it would take more than one man to do the coring. Sometimes one man will core it; sometimes it takes two. They move right with the table, take their ladle, and travel with it, the same as if they were standing still.

MR. MUELLER: Does one man handle the ladle?

MR. SLEETH: Yes, it is a ladle that holds about 60, or more probably, 70 pounds.

MR. MUELLER: The same thing could be carried out with brass, making certain changes on account of the condition of the sand, and things like that.

MR. SLEETH: As to the sand balling up, I am satisfied the sand does not ball up because we do not carry it very far

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with the conveyor, we do not need to. In the iron foundry, from the time we make the mold and pour, until the mold is shaken out, that same sand is back again in twenty minutes. The sand is not touched by the men in any way. It simply goes down through the conveyor. In the brass foundry the sand is shoveled into a screen by hand; in the other case it is shaken out through a grating. The sand drops through the grating and is wet there, and then taken over head to the machine.

A MEMBER: Can you tell me if there is any economy in a foundry melting from twenty-five to forty tons by continuous pouring?

MR. SLEETH: That would depend altogether on what you are pouring. I think about the lowest we have ever run was forty to fifty tons. We lined the cupola down very small for that. We run a 48 inch cupola about the same rate that Mr. Hawkins spoke about, 10 tons an hour, and run it full. We run ten hours running time. We have run down to 5 tons. It takes a little more lining up.

A MEMBER: Where would the economy come in in case you have flasks break?

MR. SLEETH: The economy comes in the room that you occupy for your molds and the handling of the sand. The sand that we pour into is back to the machine again in twenty minutes. Now if you had to handle that sand and let your molds go for an afternoon you would have a tremendous pile of sand and molds accumulate. In this case we get the sand, the flasks, and everything back empty every twenty minutes.

A MEMBER: In that moving platform is there any jarring, or anything to disturb the molds?

MR. SLEETH: A very slight jar. In fact, we have been running it for about nineteen years, but have rebuilt it. When it was first put up everything was new, we had to work it out

ourselves. There are two or three shops in the country to-day that are modeled after it. There is very little shake to it if it is working right.

A MEMBER: Do you use any particular type of molding machine?

MR. SLEETH: No, we do not. We built some ourselves; some we bought. We use the hydraulic system, that is with small cylinders at high pressure, 1,250 pounds, the cylinder being only one and a half inches. For the air system we have to increase our cylinder, and use our air at about 100. We have both systems, as we are in the air business in one sense, making a great many air pumps.

MR. CRAWFORD: In regard to keeping the tuyeres open all the time, or whether you keep both sides of the tuyeres open at the same time, you say you do not keep the upper tuyeres open all the time. I presume when you start you do have both sets of tuyeres open?

MR. SLEETH: Some times you have to, if it has a tendency to close up the lower tuyeres, we open the upper ones. At the beginning we kept the upper ones open all the time, but we found it was not necessary.

A MEMBER: You only use the upper tuyeres when an emergency takes place?

MR. SLEETH: In fact, I do not know when we have used the upper tuyeres. We do not touch them at all. They are made so they can be closed off, or opened.

A MEMBER: I would like to ask a question with regard to the shutting down time for the noon hour. I understood Mr. Sleeth to say that they shut down two hours at noon time.

MR. SLEETH: Not at noon time, but in case of an accident.

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MR. BRAUGHTON, Medina, N. Y.: To us who are not running continuous heats the question would arise in our minds whether or not there would not be trouble more or less with slag and the things that you generally dump from the last end of the heat. When you start up how do you get operations again in working order; how do you get rid of the slag that would naturally accrue? Another question, do you not have a heavier cutting of your lining?

MR. SLEETH: Well, that naturally follows, the longer the heat certainly the more you cut out your cupola. If you run for six days continuously you would burn it out completely starting with a smooth lining. But we do not have any trouble from slag. If you will notice in the paper, at 12:00 o'clock we make it a point to have all the metal tapped out. We tap all the slag say twenty minutes before 12:00 o'clock and, have all the slag run off. We shut the blast off, run the metal down, and get it out about quitting time. We stop all the openings up tight. There is very little iron comes down after that shutdown. Before we open the cupola up for work, if there is anything in it we drain it out, and put our blast on it full so as to get up the heat quickly. We may pig about three hundred pounds, and then are ready to start up again.

MR. BRAUGHTON: You have perhaps never held the cupola over two hours?

MR. SLEETH: Not to my recollection. I would not want to do it very often, not unless well prepared for it.

MR. BRAUGHTON: You prepare by putting on a greater amount of coke perhaps before shutting down?

MR. SLEETH: Yes sir.

A MEMBER: May I ask again what is the smallest day's run that allows of economical conditions under which to run continuously?

MR. SLEETH: About the smallest I think was 50 tons that we ever ran. You see the way that we run we cannot very well change our system, because we have not got the room; and we would run one day full and the next day we would probably shut down if we were running as slack as we are at the present time.

A MEMBER: What I meant was, what would be the smallest amount of iron to be melted per day or per hour to make continuous melting economical?

MR. SLEETH: I would not like to say that because I do not know what you are making. There are a great many men that come down and see our process, and they think it is a good thing, and they talk about putting it in. We ask them what they have? They say they have something like 20 or 30 tons. I cannot see where the continuous process would pay them.

MR. CUTTLE: It seems to me that the process as you have stated is applicable where molding machines are used, and the type of molding nachines would depend very largely upon the size of the castings, not the number of molds, but the size of the castings you had to pour. That would vary from day to day as to the character of the castings. I would like to ask as to about what would be the minimum amount of hourly or daily run that from your experience would be considered economical for the continuous process?

A MEMBER: I could answer that; two tons, where there is no molding machine, and the run would be economical too.

MR. CUTTLE: In the use of molding machines I found that the continuous process is going to be particularly indispensable and while a little different method for the working has been adopted, I wish in our foundry to obtain if I can from the experience of our good friend here some of these essential features. So I would like to ask another question, whether there has been any jarring or misplacing effect in the molds themselves?

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MR. SLEETH: We make some molds that have thirteen pockets hanging down, in our smooth molds; but there are much larger molds that we have not put on the table at all because our green sand cores are just held by a few fingers, and we would not risk putting them on. But we make lots of molds that have quite deep pockets hanging down, and there is very little jarring to it. The table has a slow movement which eliminates jarring. If it were moving fast, it would be different I suppose.

MR. CUTTLE: The point is that the displacing of the sand in the molds gives you very little trouble. I thank you very much. Do you think it would be practicable to put in a plant of that kind where we handle about 2,000 molds a day?

MR. SLEETH: That would depend upon what it was.

A MEMBER: In brass?

MR. SLEETH: You mean by the continuous system?

A MEMBER: Conveyor and continuous melting, with probably a melt of all the way from fifteen to twenty tons a day.

MR. SLEETH: The only thing that I see about it would be the casting. Brass is a little harder to handle than iron in casting.

A MEMBER: A thing of that kind involves a great deal of money; and you having experience in that and good judgment I would ask whether you think it could be handled, if not in one way, probably in another?

MR. SLEETH: So far as the conveying system goes I do not see why you should not handle brass the same as you do iron.

A MEMBER: That is right, I cannot see any difference in that either, so far as the pouring proposition goes, if a man

has full control of his metal I do not see why he could not pour brass as well as iron.

MR. SLEETH: We have a large bull ladle that they turn right out as a man comes past. You could not do that so well in brass.

A MEMBER: Oh well, you could disconnect your ladle, you know, and fill it just the same, connect it right up if you have some kind of a shackle and hook.

MR. CUTTLE: We are not doing it, anyhow.

A MEMBER: Do you think it could be handled all right?

MR. SLEETH: I do not see why it could not be.

MR. BRAUGHTON: I would like to ask Mr. Sleeth, whether or not from his experience he would recommend to a shop that is making a general line of castings, some being molded on machines, and some by the floor workmen—whether he would recommend this continuous process for such a shop that is melting say from 15 to 25 tons?

MR. SLEETH: No, I think not. I do not think there would be enough in it, you would have to melt so slow. I do not know, however. You see I have not had any experience with melting the very small tonnage such as has been spoken of here.

MR. BRAUGHTON: Supposing that you could handle a smaller tonnage, would it be practical to put on this table or carrying device that you speak of different kinds of work at the same time? For instance, a man might be molding something on the machine while another man will be doing some kind of floor work, for instance, would it be practical to take the same man to pour different classes of work? Would it be economical?

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MR. SLEETH: I do not know why it should not be. One thing about continuous is that your iron is practically the same from the beginning to the end of the heat. If you had a great variety of work to make in which you would have to use one iron, one per cent. silicon and another with 2½ per cent. silicon, you could not get them out of the same cupola. When we are running full, we run 280 tons of one kind of iron. Then of our special iron we run about 30 to 35 tons with a different percentage of silicon. That is run in a special cupola by itself. The first iron comes out low in silicon, and so on. The last is what we call common metal. So that in a jobbing shop I do not see how it would work that way with the one cupola.

MR. BRAUGHTON: I was not speaking particularly of a jobbing shop, but a general line of castings where one could use the same iron all the way through.

MR. SLEETH: As to putting work from the floor on the conveyor, I do not see any objection to that. They do it I think in Crane's shop in Chicago. They make the complete mold and a man sets it right on the table. They do it differently there from what we do it. In some shops they operate machines with one man, where we put a lot of men on one machine.

MR. BRAUGHTON: A gentleman in my neighborhood asks the question as to whether or not the continuous pouring process necessarily involves the carrying of the flasks to the cupola?

MR. SLEETH: Not in our case. Our continuous conveyor makes a complete revolution in twenty minutes, I think. We figure it out in our line of work that the molds and castings will be cold enough by the time they travel to the shaking out end. The flasks are all iron and they are shaken out of that end and immediately put back on the table and come right back to the machine. They are not carried at all, only on the conveyor.

MR. BRAUGHTON: Speaking about using the sand immediately, do you experience any trouble whatever with the sand

in a warm state? Of course, from the floor molder's standpoint, he would not like to use hot sand. I have seen troubles arise from using hot sand. For instance, sometimes we find it necessary to make a mold immediately after the sand has been shaken out, for various reasons. Perhaps some times a casting has to be made that we know nothing about previous to the heat being put on; and in using that hot sand we experience some difficulty, particularly if the casting is somewhat heavy.

MR. SLEETH: In this table that we call a continuous table our castings are not heavy enough. The sand is hot when it is shaken out, but when it is wet and it is elevated and then comes back and forward with this reciprocating conveyor, by the time it gets to the machine and to the iron patterns it is all right. We have to keep the patterns warm to keep the sand from sticking to it. If the sand is hot and you core it, and the core stood any time it would draw dampness from the steam; but that trouble was provided for. If you put hot sand on a pattern it will stick to it, or if you put hot sand in it, it would steam your cores.

A MEMBER: About what is the average weight of the casting or molds?

MR. SLEETH: The heaviest that we make on that table, two castings in one mold, the heaviest two castings weigh 45 pounds, they go down to ounces, probably thirty-two or forty in a mold, whereas the heavier are two in a mold.

MR. BEST: The question has been asked whether it would be economical to run a small melt with the continuous process?

MR. SLEETH: Well, that depends altogether on the size of the cupola as to your continuous melt. I know one place where the cupola is 36 inches in diameter, running from 7:00 o'clock in the morning until 5:30 in the evening. Out of that they get 60 tons a day easily. The diameter is 36 inches inside of the brick lining. It is never stopped up from 7:30 a. m. until 5:30 p. m., continuous running. The sand is conveyed and returns right back to its place. The work of casting is continuous. These

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are stubborn facts. If any person wants to cast two tons a day you can run it as easily as you like providing you buy your cupola according.

MR. BRAUGHTON: That all sounds feasible, but we must remember one thing—I would think so at least—that you have to have a certain amount of help there to operate that small cupola. Would it be feasible to undertake to use the men who are pouring in some other part of the work? If so, that would perhaps hold good; otherwise, it seems to me that the cost of labor would so run up that it certainly would enhance the price of casting.

MR. SLEETH: That is why I would not like to say how low you could run. Our experience has been from 50 tons up to 280 tons; the casters do nothing but cast, the machine men do nothing but mold, and the shakers-out do nothing but shake-out, that is all they do.

MR. BRAUGHTON: I can quite understand where they use continuous pouring making such things as bed-steads, where a wrought iron rod is to be put in, that it takes up a tremendous lot of wire. The wire has to remain in the sand, I can understand how they take care of that.

MR. SLEETH: That is the reason I would not like to go on record.

MR. BEST: I think there is some little misapprehension with reference to bed-steads.

A MEMBER: If there is anybody here from Philadelphia he might be able to tell us what the Enterprise people do with their continuous pouring system. They were going to have a table and put the molds on it and cast with a bottom pouring ladle. The pourer was to stand there with a lever in his hand and pour for four or five hours; the iron to be tapped from the cupola into this pouring ladle. That was the idea that they laid

their molding machine shop out on. Maybe some Philadelphia man can tell us whether they are working it out.

MR. CRAWFORD: Are you sure it was the Enterprise Company? Mr. Custer has an arrangement something like that. He is at Tacony, Pa.

A MEMBER: The question is asked as to whether you know any way of preventing holes in the ladle after the tenth filling.

A MEMBER: When you shut down for an hour at noon, do you have any trouble with freezing at the tapping hole when you go to tap out again?

MR. SLEETH: We had that trouble in the beginning. The cupola man was always afraid it would freeze; but I do not think we have had any trouble with the cupola in that way for years. I remember several years ago we had the breast out and put another breast in. We used small brick for a three quarter inch opening, something like that. I do not remember for years of the tapping hole freezing.

A MEMBER: Do you have any particular method of obviating that difficulty?

MR. SLEETH: This is what we do. After the metal is taken out we just stop the slag hole with sand, stop the tapping hole, and it does not melt any worth speaking of. If it does, it does not freeze.

MR. FORD: Mr. Sleeth and I have had the good fortune to be associated for a number of years. There are a great many good points about Mr. Sleeth's foundry that have not been brought out here to-day which are very interesting, methods by which he has been able to get out this immense tonnage; such as sanding his cores down from overhead in a little wire basket, such as you see in stores, and also an ingenious device for taking out

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the cores and using them over again. I do not want to take Mr. Sleeth's place in this. I know he is rather reticent and very modest, or he could have told you a whole lot more than he has.

There is one point that I would like to ask Mr. Sleeth which has just been brought out; in melting a large tonnage that way what has been the actual loss, taking a month's record, between the iron charged in the cupola and all the iron accounted for; in other words, we hear so many statements as to the varying losses. Certain records covering a number of years show that it runs from about 2.8 up as high as 3.5 per cent. It struck me in handling that immense amount of metal he might have some accurate records that would be interesting. I would like to ask if he has?

MR. SLEETH: I do not know as we have any actual records but I think our loss runs between three and four per cent We do not clean any of our sprues, they go in just as they come from the molds. We have large buggies, and when they shake out the castings, they take the gates and throw them into those buggies. As soon as a buggy is filled it is put on an elevator and the buggies are dumped right into the cupola without cleaning the sand or anything else off. A great deal of dirt goes in along with it. In our cleaning room we could not commence to clean the gates off. We run between three and four per cent. of iron loss that cannot be accounted for, it has gone out in the smoke, or difference in weights, and so forth.

A MEMBER: Do I understand that the core setting and pouring is done by the man moving with the table?

MR. SLEETH: The core setting is not. The pouring is. The table is large enough for a man to stay on it with the mold, and there is an overhead carrier, so that he simply stands this way, and the carrier travels with him as he is pouring. As soon as he has poured and is at the end of his trolley line, he steps off the table and comes right back to the cupola. The coring is done by men standing and dropping them in as they pass, or may be taking a couple of steps. It depends on the number of cores.

A MEMBER: And the table is moving continuously all the time?

MR. SLEETH: The table is moving. It is not supposed to stop from a quarter after seven until twelve o'clock. It does some times. (Laughter.) But it is not supposed to.

MR. BRAUGHTON: I have no further question, but I just simply want to say this, that I believe that every gentleman in the room, for the information which we have received this afternoon from Mr. Sleeth, would like to testify his appreciation. I would therefore, move a rising vote, which will also give us a chance to rest our chair, as a testimonial to Mr. Sleeth of our gratitude for the information he has given us this afternoon.

The motion was promptly seconded, and the question being taken, the motion carried unanimously, with applause and vigorous clapping of hands.

MR. SLEETH: I certainly feel thankful for this. I never expected anything like it, or I might have been loaded better. (Applause.) I would like to extend an invitation to you all if you come through Pittsburg to visit Wilmerding just outside of Pittsburg on the Pennsylvania Railroad, and to assure you that you will all be welcome to come and see anything that is going through the shop. The Company is always willing to have you go through the foundry. Sometimes they do not allow us to go through other parts of the shops, but we will be very glad to show the foundry especially to all members of the American Foundrymen's Association. I sincerely thank you all for the interest you have shown. (Applause.)

MR. SEAMAN, Pittsburg, Pa.: Mr. Sleeth having extended to you such a hearty invitation to come to Wilmerding and see what he is doing, I want to charge you before you go that you prepare yourselves to have answers ready for Mr. Sleeth's questions, because he is not only capable of putting questions to you, but he will put them. (Applause.)

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PRESIDENT ANTHES: I may say that in appropriating what Mr. Sleeth has told you, I was at the Westinghouse foundry this Spring and was given a very cordial reception and extended every courtesy, even being given the privilege of having my lunch in the dining hall which is reserved for the officers of the Company. Mr. Sleeth has a great many appliances there which are of interest to foundrymen, and you feel that the day goes by all too soon when you try to look at everything he has to show you. I wish that every foundryman here would accept that invitation at its face value and that you will avail yourselves of it whenever you have the opportunity to visit the Westinghouse foundry; because it seems to me that this is a process that we will soon have to know how to handle in order to pour quickly and economically where we have very large castings and only a small floor space. It is highly desirable unless you want to handle many tons of sand during the day-time. It is quite possible that we will have a little spare time after the rest of the papers are concluded. We will not have any more tonight because the Brass Association will now take charge and so far as the American Foundrymen's Association is concerned, our program for this afternoon will conclude now; but if there is any time later we would like to resume this discussion, because I myself feel very greatly interested in it, and I think there are more points that might be brought out by further discussion. I think we will put that before you at an opportune time.

MR. SEAMAN: I hope you will all get the opportunity to go out and see that foundry. We expect you all in Pittsburg in 1910, and we will then show you, I have no doubt that Mr. Sleeth will have planned, all other things in which you will be interested.

SECRETARY MOLDENKE: Our business has been so large and there has been so much of interest that I think we will have to have a closing session on Friday morning as well as our session tomorrow morning, so that we can be sure of hearing all the good things that are coming. We are trying our very best to get a booth for the moving pictures. If we can secure it any-

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where in town the moving pictures will be given tomorrow morning.

After some further routine announcements regarding tickets for entertainment, etc. the session now adjourned to 10:00 a. m. Thursday, May 20, 1909.

FOURTH SESSION—THURSDAY MORNING, MAY 20th.

The Convention met pursuant to adjournment, President L. L. Anthes in the Chair.

DR. MOLDENKE: I would like to call your attention to a little item that appeared in the Commonwealth Tribune of this city this morning, viz:

> Dr. Dyer stated that he had looked over the ideas and aims of the Foundrymen's Association regarding trade education and that he was heartily in favor of introducing the courses suggested by Chairman Kreutzpointner of the Committee on Industrial Education.

PRESIDENT ANTHES: We will open our Convention with a paper by Mr. Edgar A. Custer, on "The Permanent Mold." You will see by the program that this paper was to have been illustrated by moving pictures showing the production of castings in permanent molds in all details. Mr. Custer went to great expense to have films produced for these moving pictures, and we understood that we would have no difficulty in arranging for their presentation; but the local Board of Underwriters have put all the difficulties possible in our road, so that we have not been able to obtain the right to show these moving pictures. We had a lantern set up here yesterday, a temporary booth erected and everything in accordance with the regulations as far as we knew but the Board of Underwriters has closed right

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down on us. I do not know why? I suppose possibly they may think we are going ahead too fast and they want to restrict us. I am very very sorry for this, on Mr. Custer's account, because he has gone to a lot of trouble. I visited his foundry last November and saw what he was doing. I was very greatly impressed with the progress that had been made in permanent molds, and we had Mr. Custer prepare this paper for us. I know you will find it an intensely interesting one, and it would have been much more so if he could only have illustrated it by moving pictures. There is nothing like a moving picture to show how quickly a process can be handled. However, I believe Mr. Custer has some slides with which he can illustrate his talk.

MR. EDGAR A. CUSTER: I do not propose to read this paper in its entirety. I will just give some of the points, and try to tell you just exactly how we have done it, and the steps that led to the result. I do not wish to tell any one how to melt his iron or how to run his business. We only say we have done certain things in permanent molds that are applicable to certain phases of foundry work, notably duplicate work.

And if this process is carried out in a logical manner it will do very good work. How well it could be done depends altogether on the man who does it.

We will approach the subject under the following heads:

(1) Of what material should the molds be made?
(2) What effect has such a mold upon the castings?
(3) What effect has molten iron upon the molds?
(4) What remedy should be applied for any bad effects shown?

After we have carefully considered these four points we may say that the permanent mold is ready for the manufacturer.

Lava rock makes a beautiful casting, and does not chill the iron, but it wears away so rapidly that we cannot use it. After experimenting with a number of substances we came down to plain old cast iron. We found we were able to do a great deal of

good work with it. It is not much trouble to make with a machine an iron mold, and we can calculate the expansion and contraction to a nicety. The only question that arises in an iron mold is, does it chill the iron? How are we going to avoid that? A great many people have tried warming up their molds; but that has objections that have been set forth in the paper here, and we have come right down to the point of using an iron mold, chilling swiftly to the point of setting, and then taking the casting out, as being the whole basis of this work. If you allow your mold to get too hot it will distort, and the distortion will become permanent. So that we prefer very much to have the mold at say 150 to 300 degrees. After it has reached the 300 degree limit we let the mold rest a while. In order to preserve this average heat we proportion our molds so that pouring at regular intervals the heat never rises above 300 degrees F. We obtain this result by putting quite a large amount of iron around it. When we first contemplated using permanent molds it was considered a foregone conclusion that unless the interior of the mold was heavily coated with some inert substance, the casting would necessarily be chilled; and extensive arrangements were made to prevent or to remove this chill. (Reading from paper, page 84, under subtitle of "Effect of Mold on Casting.")

The next step in this line of reasoning was that if the contact with comparatively cold iron on one side did not necessarily chill the casting, then contact with iron on both sides need not chill it. (Reading further from same portion of his paper.) There is not a particle of sand used in this "T" shape fitting. It takes twenty-five seconds to make one of those. While we are on this subject I will show you here the first casting that was made in the mold. (Exhibiting actual casting.) I would like you to look at that when we are through with the talk. Here is a casting made with the same core and the same mold after thirteen months of constant use. (Showing another casting.)

Here is a 2 inch mold. In order to get the effect of robbing the metal of its heat swiftly—which is the basis of this process—to the point of setting, we require a great deal of iron around the casting. This little mold that makes a casting only eight and

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one-half pounds in weight so that we can pour rapidly and yet not allow the temperature of the mold to rise above 300 degrees F. weighs 500 pounds. That mold has been used seven months. The photograph was taken about two weeks ago. The core that was shown on the screen before that is the same core that was in use seven months ago, so that we feel reasonably sure that a mold will last some length of time.

A MEMBER: How many castings were made with that core in seven months?

MR. CUSTER: Oh, in the neighborhood of four thousand —probably more than that. At the time this paper was written it was 3,500. It has been in use ever since. My paper was written about seven weeks ago. We have quit counting.

A MEMBER: How many castings can you make before you have to stop and let the mold cool?

MR. CUSTER: In that mold we can make about one every forty seconds, and keep that up all day. We made two a minute in the mold and kept it going for about three hours; but the mold was pretty hot at the end of the three hours, so that we lengthened up the time a little bit to allow the surface of the mold to radiate heat. You can do very comfortably about one in forty or fifty seconds. We tried no artificial means to keep it cool we depend altogether upon the bulk in the mold.

You will observe that in using these molds you take no precaution against shrinkage. We depend altogether upon the fact that chilling molten iron swiftly to the point of setting makes castings that are homogeneous, and thus the shrinkage strains due to regular cooling are reduced to a minimum. (Here the speaker read further from his paper, at page 86.) I want to show you a trap mold. There is the mold that made this trap that we exhibited here. It weighs forty-two pounds and is made on a sand core. You can pour one of these about every seven minutes into that trap mold without heating it up too much. The mold itself weighs 1,700 pounds. You will note that

it is balanced so that it can be easily turned. The mold is closed and clamped, and turned right up to pour. You will notice the pouring holes coming down through there. You pour from the top into them. It is taken out and within four seconds after it is poured the mold is opened.

This shows the crack that occurs in the cooling of a pipe mold. Those are the only evidences of deterioration in that mold. That was the worst casting I could find and I show that picture so as to show exactly the effect caused by it.

Now we find that we can make castings in a cold mold just as easily as in a warm mold, but so long as there is any iron rust or water in that mold you do not need to tell a man that there is moisture in it after he starts to pour the iron. (Laughter.) We do not attempt to keep the molds from collecting dampness, because that is impossible. We have found that when we have a mold out in the open air it gives us no trouble with dampness collecting, but as soon as it is kept in the shop it will collect dampness. And the instant that you pour iron into it, it will condense moisture on the face. If you wipe it out carefully before you start to pour, that will suffice.

I have shown that the permanent core should be used in a great many cases; in all cases, in fact where the core is straight or if it is a combination of straight lines, say at right angles or different angles; or where it is not a regular curve, or a combination of regular curves, or a combination of regular curves and straight lines, you can use a permanent core and pull it right out of the mold without any effort.

This shows a 4 inch pipe, 5 feet 3 inches long from end to end, and this is the core it is made on. We pull that core right out of the mold, open it up, and drop the pipe out. The pipe is a little less than a quarter of an inch thick and wieghs 65 pounds, and that particular core there has a total of $\frac{1}{16}$ inch taper on it, although it does not require any taper to pull it out. We considered that when we first tried it.

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There is a 4 inch mold on the table, ready to be closed. We substitute this sand core for the iron core and pull it out hydraulically. That is what we are getting ready now.

There is an old 4 inch pipe with a sand core. Here is a plain piece of cast iron turned to equal the interior diameter of the pipe.

That picture shows the molds on a revolving table for continuous pouring.

There are the pipe machines. The cupola runs continuously. The table revolves in this direction. We have thirty-five pipe molds on that machine.

I have shown these to give you a good illustration of the time required in pouring permanent castings. We have thirteen molds making pipe from 2 inches to 6 inches in diameter. The table makes one revolution in seven and one-half minutes, and at that rate of revolution it will produce a casting every fifteen seconds. Under those circumstances we find that in a run of ten or twelve hours our molds never go above 250 degrees F. To get this uniform time limit it was necessary to put quite a lot of iron into a quite large table, which is moved by hydraulic power. It moves by jerks with an interval of fifteen seconds between jerks. The iron comes in here. The ladle is automatic in its operation, moving up and down and pouring the pipe as it passes through, the capacity being about seven tons an hour. The molds are closed and opened automatically. The table operates automatically in so far as the pourer cannot pour a pipe as long as the mold is in position, nor can he move the table as long as the ladle is in pouring position. The mere fact of moving the ladle will release the table and allow it to make one more step. Until it does make that step he cannot drop his ladle into pouring position, or pour from it.

A MEMBER: How long is the period after pouring the capacity of the mold before it is time to lift it? And how is the casting lifted?

MR. CUSTER: The question is asked, what about the automatic lifting of the pipe from the mold, and how long must that pipe remain in the mold until it is time to take it out? The time necessary for a 2 inch pipe ranges from three to six seconds. You can take it out within three seconds, and you must not let it go longer than six seconds. In a 6 inch pipe which is much thicker, the time ranges from five to sixteen seconds, and you have an interval every ten seconds in which you can open the mold.

The automatic device for lifting the castings out is a combination of two hooks that are hung on each side of the mold. As the mold opens these hooks come in and automatically pull the pipe right out. The time of opening the mold though is under the control of the operator. He runs it along depending upon the size of the pipe.

A MEMBER: Only one man operates the whole table, as I understand, and pours it off?

MR. CUSTER: Yes sir, the pouring and moving the pipe, and all the rest of the work, cleaning out the molds and setting the cores. There is one feature that we have not touched upon, and that is the temperature of the molten iron. In all cases, when using the permanent molds, the iron as it comes from the cupola should be very hot—

A MEMBER: How hot?

MR. CUSTER: Just white hot. As long as the sulphur and phosphorus are low you have pretty nearly ideal conditions for permanent mold work. Some care may be exercised to prevent the casting sticking in the mold. When we first started this process we coated the molds about one in every five or six castings with a mixture of graphite and gasoline; but after fifty or sixty castings are poured the mold becomes seasoned, and we do not pay any attention whatever to putting any substance in the mold. The only thing needed is to wipe it out with a greasy rag occasionally any time that we see any little dirt in it. So

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that we do not use any material whatever. There is no necessity of putting a coating inside to prevent chilling or sticking, because when once seasoned it is almost impossible to burn iron into the mold. You will find it leaves a thin thickness of probably one-thirty-second of an inch in which the iron is apparently black, but carbonized over the face of the mold. When once that litt'e skin is formed you are perfectly safe against sticking when pouring metal into the mold. To a certain extent trouble is experienced through different thicknesses of the cast iron. This is one of the most difficult castings that we meet with, about one inch thick through here, and less than a quarter of an inch thick at this other point, and it requires rather close manipulation to produce that without chilling the outside rim. That is accomplished by using iron of about 2.5 per cent. silicon and low in sulphur. That is the only specification we put on to make a casting of that description. We pour it hot, with iron about 2.5 per cent. silicon and as low as we can get it in sulphur. Outside of that where the walls are all reasonably the same thickness there is no difference whatever in the casting, or at least no difference that you can find.

There is one thing that should be brought out strongly, and that is that chilling molten iron swiftly to the point at which the iron sets. The chilling swiftly the iron to the point at which it sets produces a cast iron that is absolutely homogeneous, or as nearly so as it is possible to make it, and entirely free from shrinkage strains, as shown by this casting that was taken out of the mold at a bright yellow heat and thrown into ice cold water. There is no crack in the surface or otherwise on it. Here is a little hammer that shows a complete absence of shrinkage strains. The gates there are not quite one-eighth inch thick, two gates on each side. That was taken from the mold at a bright yellow heat and thrown into ice cold water, and the gates are not cracked. It simply shows the utter absence of shrinkage strain and the homogeneity of the iron.

Now, what peculiar molecular action is set up that produces this result in an iron that when cast in sand exhibits all the defects we are accustomed to see in sand molding. (The

speaker here read from page 95 of his paper.) You will notice here that the gates instead of shrinking, the iron is pushed out on the top. Dr. Moldenke showed that same phenomenon in cast iron at your meeting last year at Toronto. This is another exemplification of it except that it is not a specially produced piece. All these excrescences on here are squeezed through the pores. You can see them all over the surface. Here is one with the excrescense on the top. A broken section will show that the bar is of equal hardness throughout. This is molecular action that does not take place when the metal is cast in a sand mold.

Now let us go a step further. (Proceedings with paper at bottom of page 95.) I have here a bar of iron that was taken from the mold at a bright red heat, and one end of it suddenly quenched in cold water. This end is as hard as the hardest tool steel; the other end is soft cast iron. I have here a small permanent magnet made out of a "T" that was cast. I show on the screen a section of pipe on which threads have been cut. It ranges from thirty-two to the inch to eight to the inch, square threads, every thread perfect.

I have here a tool that has a gray fracture, no white crystals about it; in fact, if you chill your iron so that it has white crystals in the mold, and then throw it in water it is absolutely useless for this purpose; but take it out at a bright red heat and dip it in water and you can make a grinding tool from it that will last indefinitely. It does not matter whether that iron contains three per cent. of silicon, or two per cent. of silicon; it does not matter whether the iron has 1.5 per cent. phosphorus, or .01 phosphorus and .01 sulphur, the effect is precisely the same in either case. Moreover, by casting in iron molds within that range there is absolutely no difference in the tensile strength as far as chemical constituents are concerned, as long as you do not touch the carbon. Given uniform carbon and it is immaterial so far as its ability to harden or to retain magnetism is concerned. I will except magnetism. There is absolutely no difference no matter what the chemical characteristics of the iron are. But if you take that bar of iron and put sulphur in it you cannot magnetize it. Why, I do not know.

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Here is a small piece of iron which shows

Silicon	2.28
Phosphorus	1.21
Sulphur	.108
Manganese	.41
Total Carbon	2.65
Combined Carbon	.44

You cannot touch it with a file, it is utterly impossible. Heat it to red heat, it does not need to be held in the annealing furnace any length of time, it simply has to be warmed up to a red heat. Take the bar of iron and so treat it, hold it in the flame until the iron drips from the end, dip in water, and it can be tempered and retempered repeatedly and its original hardness restored. I have one that was tempered six times with a total distortion of .002 in the threads. The threads are still perfect.

Here is a small ploughshare. We can make six of them a minute. Drop this in water and you have tool steel. Excuse me for taking so much of your time but in this small casting there was only a distortion of .002 to the inch in the thread after six times heating and quenching in cold water. The casting is on exhibition here. (The speaker further quoted from his paper on page 97.) This is a step toward what the malleable iron industry is doing to-day by annealing. We are simply taking the first step toward what the malleable iron is doing. There is no difference so far as tensile strength is concerned whether iron is high or low in phosphorus, or high or low in sulphur. We can find no evidence of change in castings made in permanent molds so far as tensile strength or crushing strength is concerned. We only say the reason why we get those results is because we cool the iron swiftly to the point of setting, and then take it out of the mold and allow it to cool normally. That applies as I have said to a limited amount of work. How limited it is depends altogether upon the man who wants to work it. How far it can be taken depends upon the engineering skill of the present day. When the same engineering skill and technical acumen is applied to it as is applied to the molding machines we may see some wonderful things in the future. If we carry this process still further there is no reason why the permanent molds should

not be set right against the blast furnace and the castings turned out there. We have no expert laborers at our plant, it has all been done by ordinary labor, and the boys all work, and so does the boss. (Applause.)

I will be very glad to answer questions so far as I am able, or to hear any experiences that anybody has had. I will be glad to hear your experiences for I want to know more about it myself.

DISCUSSION OF MR. CUSTER'S PAPER.

A MEMBER: How heavy castings have you made?

MR. CUSTER: The heaviest castings we have made weighed 110 pounds. They were 6 inch pipe.

A MEMBER: How do the gates compare with the sand mold gates?

MR. CUSTER: We find that in pouring permanent molds we have to make a greater allowance for gates than we do in sand. We have to give quite a liberal amount of opening so as to allow the iron to flow quickly and swiftly into the mold. We have to put more gates in than we would in the ordinary sand castings.

MR. SCHUTZ: Did you ever have any experience in that line in brass?

MR. CUSTER: No, I have not, I have not tried it; although I cannot see any reason why an expert brass pourer should not be able to pour into an iron mold as easily as in brass. I can see no reason why brass casting should not be poured in an iron mold, provided the mold has plenty of resisting power for your brass; I mean to say, the requisite thickness for the molds.

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MR. SCHUTZ: I have tried to make them, but after the first two or three castings I failed.

MR. CUSTER: You did not have enough metal in the mold.

MR. SCHUTZ: But I am satisfied I am on the right track, the same as you people, but it will take some time to experiment.

MR. CUSTER: There are only two resisting forces in metal, expansion and contraction. The forces of expansion of molten metal to the point at which it will set is easily controlled; in fact, if you make your mold rigid, and close it, the expansive forces in pouring into it until it is set will simply force the metal into every crack and cranny of the mold. It will run up to a sharp razor edge almost. You can see here how it has run up to the sharp corner of that claw-hammer until it will cut you if you rub the finger over it. Here is one of the biggest castings we make, an ordinary brake-shoe. A brake-shoe is a pretty common thing, you know, some people can make lots of them. We would like to get into making some of them. We are going to do it some day. I do not know of any difficulties in brake-shoes.

MR. SCHUTZ: Do I understand you right that you use for a coating gasoline and graphite?

MR. CUSTER: Only when the mold is new. Fifty or sixty castings will season your mold for you. But if you are going to try it in brass, do not think because brass is a lower temperature than iron that it is going to be easier on the mold than iron, for it is not.

MR. PATCH: In casting brass it was found that some part of the mold had to be made of other metal than iron, so as to radiate heat faster than iron. A part that cools more slowly will require metal that cools more slowly. Copper cools as fast as any metal, and some of the permanent molds that we use for brass castings we used copper, and some steel, in accordance

with the speed at which heat is radiated. In that way we have made brass castings very successfully.

MR. H. M. LANE: There is one interesting point in that connection with regard to copper anodes, they have been cast in copper molds successfully on account of the fact that the radiation was so rapid from the copper that it did not have time to get the mold up to the melting point.

MR. PATCH: All copper ingots are cast in copper molds.

MR. LANE: One other point that I think worthy of note in this connection is that it is evident that the crux of this process lies in the recalescence point; in other words the iron castings must be taken from the mold above the recalescence point, but below the point of setting. If that is true the results that Mr. Custer has here will undoubtedly follow.

MR. CUSTER: In our work we find that if you will make a diagram, in which this point is the temperature at which the molten metal is poured, out in here a little curve of expansion rises that way, and then runs along in a straight line of about 200 degrees, and then it commences slowly to go down and the shrinkage begins to take place; but that shrinkage curve at the high temperature is very flat. It is not until after it reaches about 700 degrees that it commences to go down rapidly.

A MEMBER: I would like to ask about the phosphorus in the iron. You spoke about using low phosphorus.

MR. CUSTER: I did not think it necessary to use low phosphorus. I said the ideal iron after pouring in a permanent mold would be one that contained low phosphorus, but that it is immaterial whether the phosphorus is high or low to accomplish certain results. I would rather pour iron with 0.5 per cent. phosphorus than 0.1 phosphorus, on account of its running ability, and it does not seem to vitiate the strength of the iron at all. I ascribe that to the fact of keeping the iron homogeneous and

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preventing the segregation of the sulphur or carbon. That is what makes this iron the strong and tough iron that it is. The phosphorus has not very much effect on it if you handle it right, but as soon as you pass the danger line then you get your trouble.

A MEMBER: How is the tensile strength test as compared with transverse?

MR. CUSTER: Taking the same section poured in sand, and poured in permanent molds, there is a difference of about 30 per cent. in favor of the iron mold; that is, it is stronger by about 30 per cent. You can increase the transverse strength by letting it stay in the mold a little longer, at the expense of the tensile strength. A section like the brake-shoe we leave in the mold about seven seconds. It takes from seven to ten seconds to pour it. You leave it in about seven seconds, and altogether it takes about thirty or forty seconds to handle it by hand. You had better say a minute if you are going to do it by hand.

A MEMBER: What is your experience in regard to warping when you take the castings off so hot?

MR. CUSTER: They do not twist.

A MEMBER: You would not dare to take them off in sand and lay them around promiscuously?

MR. CUSTER: Undoubtedly you would not. I wish I could show you how we pile all those T's, in a moving picture, and let you see how the operator handles them.

A MEMBER: A pipe which was made long it seems to me would warp.

MR. CUSTER: We do not find any trouble of that kind if we set the iron swiftly. Warping is only due to shrinkage strain. Irregularity of cooling has some effect on it. If we lay that pipe down, dump it on the ground, I will acknowledge

that it would curve, but with reasonable care you preserve precisely the same curve as the mold.

A MEMBER: If the casting were not supported by a sand core of that size, would it not settle?

MR. CUSTER: I have never known it to. I have pulled permanent cores out of 5 foot pipes when they were so hot that the iron sort of pulled down with it, but I have never seen any of the pipes collapse.

A MEMBER: Does the pipe retain its roundness?

MR. CUSTER: Perfectly round.

A MEMBER: How long after taking out of the mold would you consider that that change would not take place?

MR. CUSTER: That depends upon the thickness entirely.

A MEMBER: Take a 6 inch soil pipe?

MR. CUSTER: Why, within fifteen seconds after you take it out of the mold and laid it on the pile, within five seconds afterwards, or about twenty seconds from the time it was poured until it was laid on the pile without injury.

MR. HENDERSON: If you have low silicon iron that would normally chill all the way through, in quarter inch sections would it be possible for you to remove it from the mold quick enough to prevent it from chilling?

MR. CUSTER: No sir. If the iron is going to chill in sand it is going to chill in the permanent mold just the same. I cannot do anything to prevent it.

MR. HENDERSON: Did not I understand that that was part of your method of overcoming the chill?

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MR. CUSTER: Yes, for iron that would chill ordinarily in an iron mold.

MR. HENDERSON: What is your limit in low silicon?

MR. CUSTER: We have run down to 1.25 or 1.30—not without a chill but without cracking your casting. About 1.75 is as low as I have gone. With sulphur I like it down below .05.

MR. HENDERSON: How much total carbon?

MR. CUSTER: Total carbon high.

MR. HENDERSON: Necessarily, in the case of that low silicon.

MR. CUSTER: Yes, carbon as high as you can get it.

MR. HENDERSON: Do not the malleable furnace people use the open hearth process in the belief that they can get total carbon down to 3.0 per cent.?

MR. CUSTER: I do not know. The malleable men will have to tell you that.

MR. HENDERSON: Well, I will put that in another way: Can you guarantee getting 3 per cent. total carbon in a cupola?

MR. CUSTER: I would not guarantee it, but I get it every day.

MR. HENDERSON: How do you get it?

MR. CUSTER: By analysis. Simply from a blast furnace. They will not give us a carbon analysis, but we analyze our own pig. Plenty of people here can tell you whether you can get any higher carbon in pig iron than I can. We only buy from one or two men. So far we have not had any trouble in

getting comparatively high carbon by that method. Some samples here show total carbon 2.65. That is a little lower than I like to use it. It shows the same results as far as the hardening tendency goes that a carbon over 3 per cent. would show. In finished casting it runs away up.

The question has been asked me, what is the most scrap that we have been able to carry in iron? I am glad that question has been asked me, because for the first time in the history of our experience for the last three months we have been using scrap because we cou'd not get the pig iron we wanted, and so we took up some scrap and stuck it in anyhow. We had to run. We had soft iron that ranged about 3 per cent. silicon. We carried 70 per cent. scrap, but what the scrap was I do not know.

A MEMBER: I would like to ask you if that ploughshare that you plunged in water is white?

MR. CUSTER: Yes sir, it is white, except that the backing is gray. I would like you to examine these castings and if you have anything to say about them or any questions to ask, I will be very glad to answer them. We have no ulterior motives at all. This is simply for information. I am put here to tell you about it.

PRESIDENT ANTHES: Possibly we will be able to have Mr. Custer show us the pictures next year. Unfortunately we were refused the privilege this year. The Underwriters have just been up and apologized for obstructing us as they have; but we find that we cannot show the pictures this year. We will have to have them next year.

Mr. Green of the local Entertainment Committee has just told me that the Burgoo and Barbecue which is to be held up the river this afternoon is going on notwithstanding the weather. They have made great preparations. The grounds where this picnic is to be held is a four acre lot covered over so that there will be no trouble from rain; and the boat which holds three thousand is also covered and nobody need be afraid of getting

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wet. They have gone to a great deal of trouble preparing this burgoo, and they do not want to be disappointed. I hope every one present will be there. While on the boat maybe we will be able to get in a little session.

As Mr. Probert is not here his paper will be read by title. It is a very interesting one.

On motion the Convention now adjourned to 10:00 a. m. Friday, May 21, 1909.

RIVER BOAT RIDE AND KENTUCKY "BURGOO."

In spite of the heavy weather a very large and happy crowd assembled at the wharf and took the great Ohio River Steamer for a fine sail. The Cincinnati Committee had prepared a great feast of "Burgoo," a typical concoction of various meats and condiments, with a splendid aromatic flavor and an African name. There is nothing on the bill-of-fare of Nations that turn out good cooks, to quite equal this, and many of the visitors stood in the driving rain to see the Kentucky African stir the bubbling and boiling mess in the huge chauldron close by the recreation buildings.

And then the Mint Juleps!—Your Secretary is not a good authority on that subject, but from three that were presented him at intervals by admiring friends, he would say that the prohibition wave of the South must be awful on the Colonels, for the Juleps were simply heavenly. But perhaps there are ways and means at hand in those regions to accommodate the thirsty, even if the percentage of accidents in foundries is thereby increased somewhat.

As many of the members and guests had to take early trains, the Committee was considerate enough to turn the prow of the vessel homeward early in the evening, and every one was satisfied—even those who went back and enjoyed some more dancing on the boat later in the evening.

As an entertainment this genuine Kentucky "Burgoo" and the river ride were certainly novel features which were much appreciated by all.

FIFTH SESSION—FRIDAY MORNING—MAY 21st.

The convention met pursuant to adjournment, President Anthes in the chair.

PRESIDENT ANTHES: Gentlemen, we may as well come to order. We have been endeavoring for some time to get a larger attendance up here, but it seems as though we were not going to get anybody else, and in fact some are beginning to leave; so we will go on with our regular business.

Unfortunately we are a little limited for time. This is an adjourned meeting, and we have a large number of papers to go through with and will not have time to do it. We will therefore ask those who are here with papers to announce their titles, and the papers will appear as usual in our Transactions and will be distributed during the coming year.

DR. MOLDENKE: There are papers here, but the attendance is so small that the gentlemen have expressed themselves as satisfied to have the papers sent around to the members, and they have also offered to send me some new points if any occur to them. We will have them all in the Transactions. There is one paper by Dr. Porter which calls for the appointment of a committee. If Dr. Porter will give us in a few words the idea of the paper, and just what it aims at, it will enable us to act more intelligently upon the subject.

DR. PORTER: In order to give credit where credit is due, I will say that the original idea of this committee came from Dr.

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Moldenke,* and it has seemed to me a very excellent plan. The idea is that a great many small foundries would be greatly benefited by setting up chemical standards for different classes of iron castings. This could be gotten out by the American Foundrymen's Association, and the work of these small foundries would be greatly facilitated thereby. The foundrymen will gain considerable information as to just what composition will be most suitable for any given kind or class of castings.

I would suggest that if the Association thinks well of the plan, a committee might be appointed to get up a little pamphlet on the subject, classifying castings and specifying the composition which is most suitable for each class. Perhaps in that connection information could be furnished showing how the cost of the mixture might be reduced. Of course there are a great many other factors that influence cost besides composition, the latter being only one point. I think all of the points involved deserve more attention than they receive; but the time seems ripe for the working up of this one point of composition at the present time. Mr. West has made a classification of iron castings and published it. I believe he classified them into thirty-four classes. It is possible that this classification might form the basis of our work.

A MEMBER: Do you mean that you would have to run different analyses?

DR. PORTER: That would only be feasible to a limited extent. In some cases we could change the composition of the iron slightly in the ladle. We could use ferro-alloys. That would be an interesting point for investigation and discussion.

DR. MOLDENKE: During the year I have had many calls from foundrymen who said that they have a regular run on certain work once in a while, and they would like to know more about what the composition of such work ought to be. The idea

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*NOTE BY THE SECRETARY: The incentive is really due to our fellow-member Mr. A. M. Loudon, of Elmira. He as well as many other foundrymen felt the need of this and wrote the Secretary so.

of this investigation really would be carried out best by a Bureau, such as Mr. Anthes suggested should be formed for a foundry industry. But in the meantime, pending the formation of such a Bureau, the thought is that it would be worth while to start a line of study of this sort and issue literature on the subject of the best composition for different classes of castings.

A MEMBER: If a foundryman was going into any specialty he would have to charge the cupola accordingly.

DR. MOLDENKE: If he has a whole day's work on that specialty, he could run a whole day's heat, or he might make a couple of charges if he wants to; but the idea is to try to get the composition of the best examples of work of a certain kind. It may not amount to anything, it may work out wrong, you cannot tell; but the question is coming up so often that there seems to be a chance to help some of our foundrymen who do not know much about these new movements and to set him straight. If it works out well we will continue it. It will cost nothing except a lot of work on the part of the committee.

MR. BEST: I think to a foundryman who is making specialty work this is a matter of vital importance. For instance, take the class of work we are making, heaters for heating water, of which we make quite a quantity. It should require a special method whereby to obviate the difficulties in expansion and contraction. I think that to foundrymen in general that this is a matter of great importance; not so much to the jobbing man, but to the specialist who is making special things right straight along. I would be delighted if such a movement would go through.

PRESIDENT ANTHES: You have heard Dr. Porter's paper. Are there any suggestions regarding it? Will any one put it in the form of a motion that such a committee be appointed?

MR. SMITH: I move that such a committee be appointed.

The motion was seconded.

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PRESIDENT ANTHES: I will further suggest that Dr. Porter be made Chairman of this committee, and let him select his confreres. The Chair will declare the motion carried with that understanding.

DR. MOLDENKE: There is another thing that has come up, that is, a request from several members of steel castings concerns, asking whether it is possible to take up the question of the formation of a Steel Founders' Association based on the lines of our Association, that is apart from any other associations who take up questions of prices, handling of labor, etc.; in other words, they seem to have seen that the Brass Association in cutting loose from us and taking up the question of the alloys of bronze, brass, etc., have had such good success that they would like to see the Steel Casting industry progress in the same way, and to form what you might call an American Steel Founders' Association. I told them I would be glad to present the matter here, and suggest that we have perhaps a committee of one, or if you will, the Secretary's office, to correspond with people during the year and ask them to come to the next convention, and we could have one section for Steel Castings papers; see if they would wish to do it. If you care to have a committee appointed, or have the Secretary's office undertake this, it will give us some information as to whether it is desirable. This is on educational lines only, not for anything else. In order to bring the matter before the house, I move that the Secretary be instructed to find out during the year whether it is possible to form an American Steel Founders' Association on our lines.

The motion was seconded.

MR. FIELD: Dr. Moldenke, would you mind stating from whom that request came?

DR. MOLDENKE: Several of the gentlemen are in the house. They are representatives of big Steel Works. They might not like to have their names made known at this time.

MR. FIELD: There are certain complications that might arise between the constitutions of the two associations which might prevent members of one from going into the other.

DR. MOLDENKE: Is there anything in our work which conflicts with that of any other Acssoiation?

MR. FIELD: There is something in the constitutions of other associations which states that it is for the same purpose as this.

DR. MOLDENKE: We would like to know what Association that is. If however there is another association taking up this educational work, all right; but so far as we know, in our business there is not any such association.

PRESIDENT ANTHES: Gentlemen, is there further discussion of this matter?

MR. LOGAN: I think that it is only fair to us that Mr. Field will say what association is in existence for that purpose? I have never heard of one. Talking about constitutions, there must be an organization if they have a constitution. If so, he ought to let us know who they are.

MR. FIELD: I would ask that this motion be referred to a committee.

DR. MOLDENKE: Suppose that my motion be referred to the Executive Board for action, how will that do? Then if you can bring before our Executive Board any information that makes unnecessary any further action on our part, all right; and if the Executive Board thinks the industry would be benefited by having such an association, then we will do it.

MR. FIELD: I will accept that amendment.

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PRESIDENT ANTHES: The motion is that the formation of a Steel Association be referred to our Executive Board for action. The motion carried.

PRESIDENT ANTHES: The next order of business, gentlemen, will be the Report of the Nominating Committee. I will call on Mr. Seaman, the Chairman of that committee, to make his report.

REPORT OF THE NOMINATING COMMITTEE.

MR. SEAMAN: Mr. Chairman and Gentlemen: I will say that our committee met, and submit the following nominations as the result of our deliberations.

FOR PRESIDENT

ARTHUR T. WATERFALL, Russell Wheel & Foundry Co. Detroit, Michigan.

FOR VICE PRESIDENTS

First District—F. B. FARNSWORTH, McLagon Foundry Co., New Haven, Conn.

Second District—WALTER WOOD, R. D. Wood & Co., (Camden, N. J.) Philadelphia, Pa.

Third District—JOS. T. SPEAR, Pittsburg Valve, Foundry & Construction Co., Pittsburg, Pa.

Fourth District—WILLIAM GILBERT, Buckeye Foundry Co., Cincinnati, Ohio.

Fifth District—EUGENE W. SMITH, Crane Company, Chicago, Illinois.

Sixth District—T. W. SHERIFF, Sheriff's Manufacturing Co., Milwaukee, Wisc.

Seventh District—ALFRED E. HOWELL, Phillips & Buttorf Manufacturing Co., Nashville, Tenn.

Eighth District—A. N. W. CLARE, Clare Stove Co., Preston, Ontario.

FOR SECRETARY AND TREASURER

DR. RICHARD MOLDENKE, Watchung, N. J.

PRESIDENT ANTHES: Gentlemen, you have heard the Report of the Nominating Committee. What is your pleasure?

MR. LANE: I move that the Secretary be instructed to cast the vote of this Association in favor of the officers nominated.

The motion was seconded.

The motion carried, and the ballot having been so cast, was duly reported and the aforesaid nominees declared duly elected as officers for the ensuing year.

MR. SEAMAN, Pittsburg: Mr. President, it has been customary at all of our meetings that before adjourning we would pass a vote of thanks to different parties to whom such acknowledgement was due. I move you, therefore, that a vote of thanks be tendered by this convention to the Entertainment Committee of this meeting, to the authors of papers, and to the retiring officers.

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Motion seconded by Mr. Lane, and carried unanimously, with applause.

President Anthes requested President-Elect Waterfall to come forward.

PRESIDENT ANTHES: Gentlemen, in introducing Mr. Waterfall, our new President for the coming year, I wish to thank you one and all for the hearty support I have received from the membership of the American Foundrymen's Association during my term in office. I trust that Mr. Waterfall—I not only trust but know—will receive the same support that I have received, and that when he retires from office he will have the same feeling of gratitude and good fellowship for the American Foundrymen's Association membership with which I now resign the office of President to Mr. Waterfall, and ask him to take the chair. (Applause.)

PRESIDENT-ELECT WATERFALL: Mr. President, and Gentlemen, I thank you for this exhibition of your good feeling. I hope I may fill the office as ably and as acceptably as Mr. Anthes has, and that I may acquire that dignity, and reflect that dignity upon the position that our former President has done. (Applause.) I will ask Mr. Anthes to kindly resume the chair and finish the order of business.

President Anthes now resumed the chair.

MR. SEAMAN, Pittsburg: I will ask Mr. Anthes not to resume the chair for a moment, but to allow our President-Elect to receive the motion that I propose now to offer. It has been my privilege in years past at the close of nearly every convention, to present such a motion, and I wish to say that I have never had occasion to do so with more pleasure than I now do, in the moving that Mr. L. L. Anthes, our retiring President, be elected an Honorary Member of this organization.

The motion was promptly seconded by Mr. Lane, was put by President-Elect Waterfall, and carried unanimously.

EX-PRESIDENT ANTHES: I can only repeat what I have said, gentlemen, that I am grateful to the American Foundrymen's Association for this kindness. You have shown me, as I stated before, during my term of office, both as a bench member and as member of your Executive, and as your chief Executive, nothing but courtesy—from everybody in the Association. Though I am retiring from the executive office, that does not mean that my interest in the American Foundrymen's Association is going to be lessened in any way. I am going to work just as hard for the objects of our Association, which are educational. I think a man can well devote his life's work to furthering the educational interests to any country to which he is attached.

I am, as you know, a Canadian, and I therefore value the honor much more because of being a Canadian, to be an Honorary Member of the American Foundrymen's Association, which is made up principally of people on this side of the line. I am going to continue as a champion of all educational movements and am going to keep right in the van of the American Foundrymen's Association and do all I can to further its interests.

There are a few points which I should like to touch upon and as I am now an ordinary bench member, I think I can say anything I like without being embarrassed by the executive end of it. So I wish to present to you a few suggestions, and principally one referring to the increase of our dues. Now, gentlemen, from my experience as an executive member of the American Foundrymen's Association, it is a fact that we practically have to run our Association on an almost empty treasury. We get up here and extend a vote of thanks to Dr. Moldenke every year, and tell him what we are going to do for him, give him an assistant, raise his salary, and all that sort of thing. We come here smilingly every year and some pay their five dollars dues, and some do not, and things go on.

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I think it behooves every foundryman in America to take an active interest in the educational features of the American Foundrymen's Association, and to send, if not more, at least one representative to our convention every year and pay his way. Every firm ought to have a membership in our Association as well as a membership for the representative whom they send here. It seems to be rather hard knocking to get up and have to say this to you members, but really every man who attends the meetings of the American Foundrymen's Association is getting benefits, and these benefits are increasing year by year.

As I said before, the five dollars we pay annually is not a contribution for which no return is received. It is an investment, and a really good investment. I think the Foundry world is waking up to the fact to-day that without the American Foundrymen's Association here in America we would be at least ten years behind the times. It has placed a standard before us. We have to keep up to that standard. We cannot do it unless we have the proper means provided.

I would impress upon the incoming executive the necessity of looking into this matter of increasing our income in some way. It is absolutely necessary. Dr. Moldenke here puts practically all his time into the affairs of the American Foundrymen's Association, at what I might call a miserly stipend. There are a lot of little preachers in out-of-the-way settlements who get a salary of about the same size as the doctor's; but here is the doctor, a man qualified to take a leading position in foundry work, a man who ought to be receiving a salary of nine or ten thousand dollars a year, without any exaggeration. Yet we as an Association ask him to do our work for us for a little stipend of $1,200.00 a year; and he doesn't even get that every year. The doctor always puts in a report showing a balance, but if the doctor did not put his hands in his own pockets, there would be no balance.

I do not want to rub it in too hard, but, gentlemen, these are facts, and I think that every foundryman in America ought to realize the necessity of contributing in some way to the accom-

plishment of the purposes and aims of the American Foundrymen's Association, which are purely on educational lines.

We stand for education, and education alone. Every educational movement has received our hearty support. There are not many here to hear what I have to say. I would like to have a full good meeting so that I could rub it in good and hard. I do not mean in any way to say anything unpleasant or unkind to you; but I wish the Foundrymen to realize their responsibility. The American Foundrymen's Association has gotten to such a state that we need more financial backing.

Gentlemen, I ask you to pardon me if I have put this matter too strongly, but I have merely expressed what I believe.

President Anthes' talk was received with prolonged applause.

MR. SEAMAN, Pittsburg: I have just one word to say in regard to what our Ex-President has expressed as to our finances. We have an excellent Secretary and Treasurer, in whom I know we all have perfect confidence. But there is one thing I must say, that he doesn't know a thing about bookkeeping. He comes here and he makes a report that so much money has been received, and he goes on to designate some of the expenditures. Now our Secretary should have $1,200.00 a year, and at our last meeting in Philadelphia, or Toronto—I don't remember which it was—it was voted to give him an assistant, that he was overworked. Six hundred dollars a year was voted for that purpose, making an outlay of $1,800.00 a year for the salary of the Secretary and assistant. Now he comes in with a report showing salaries paid during the past year of $900.00 and something over. Now you can draw your own conclusions as to where the other comes from.

DR. MOLDENKE: I guess I am a bad bookkeeper, but I think I am a good patriot, because I will tell you frankly, gentlemen, that while it would be real nice if we had this thing all going

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—I hope it will come that way—at the same time after I have sat up nights a whole week writing letters to foundrymen who have asked for information on this point and that point, I feel that I have done some little good to the country in elevating these founders who have not the ability nor the means to get such men as Mr. Field, Dr. Porter and others to do these things for them. I hope these gentlemen do not feel sore at me writing to the members free of cost what they ought to engage somebody to do. But the result seems to be that the American Foundrymen's interest stands at the front of the whole world. The English foundry interests are to-day wrestling with the problem of grading by fracture, and they are still five years behind our way.

The Germans are almost ready to beat us on some things because they have put engineering brains to work on American information. We have a Swedish Foundrymen's Association that is now in the field. France is starting to look around her and follow the American Foundrymen's Association, and they give us credit in so doing. The Germans prefer to stand on their own feet.

I think that perhaps our work is the grand work of fertilization for what the world will get hereafter. If we can get each of our foundrymen to pay for one or two memberships, we will have funds to carry on our grand work.

I thank you, gentlemen, for the re-election you have given me. I saw it in the newspaper this morning already, and I was glad to see it there, but I thought it would be surer when done here to-day. I propose to do all I can for the work as long as I live. Who knows how long that will be? I have given fifteen years of my life to this work and sometimes I feel that I am now on the downward grade.

MR. FIELD: I feel a little bit interested in the matter of finances. I happened to be somewhat interested one time when we tried to get the Doctor's salary raised, and succeeded in getting some back dues settled up and started off again straight. I

think the Doctor got his salary for that year and the year following; and we came out with a balance of fifty cents. We thought we were clean; but I see we are dirty again, if I can use that term. Last year, at the solicitation of Mr. Flagg, it was determined that the dues should be increased to ten dollars, provided there was a two-thirds vote in favor of the change. The Doctor has told you that the vote was taken and 75 per cent. of those who voted voted in favor of it, but that only 200 members in all voted. Now I am going to make another motion, that another written vote be taken this year, and that if two-thirds of the members voting vote favorably to it, that the dues be increased to ten dollars a year. We need the money. It seems a shame that an Association of such high reputation as the American Foundrymen's Association has to be fussing around every year for a little one hundred or two hundred dollars to pay a Secretary who works as hard as he does. If they will not stand for ten dollars, then I think they do not need to have an association.

PRESIDENT ANTHES: I am heartily in favor of your motion. I have much pleasure in putting the motion, which has been seconded by Mr. Seaman. All those in favor, etc.

The motion carried.

DR. MOLDENKE: Before taking up the matter of invitations received for place of holding next year's convention, there is one matter to come up, and that is the report of the Committee on Standard Specifications for Foundry Pig Iron. That committee has worked very hard and has gotten together a report, and Mr. Field will submit it.

PRESIDENT ANTHES: Mr. Field, will you present the report of the Committee?

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REPORT OF COMMITTEE ON STANDARD SPECIFICATIONS FOR FOUNDRY PIG IRON.

MR. FIELD: I am not going to read it, as it is in print, but will simply give you a little history of it. These specifications have been in the wind for about ten years, having been started at Milwaukee, and adopted by different societies. In the last two or three years there has been growing a sentiment for some uniform method of specifications to be adopted, in which the furnace and foundry could get together in the purchase and sale of iron, so that the furnace would know how it would be specified, and the foundry would know what they could expect.

The chief drawback to buying iron on analysis has been the fact that the foundry took an unfair advantage of the furnace at such times as the foundry got the furnace in the wrong place, if you can use that expression; in other words, the foundrymen got the furnaceman to accept certain specifications, with the intention of taking advantage of some point to reject the iron if the market went down. That has been a drawback which had held the furnace-man from giving as liberal specifications as he would otherwise have done. That is taken care of in this report.

A committee was appointed last year to draw up such specifications. It consisted of Mr. Henry A. Carpenter, of Providence, Rhode Island, Mr. Stanley G. Flagg, Jr., of Philadelphia, Pa., and myself. When we had this in shape we took the matter up with a Conference Committee appointed by the American Society For Testing Materials. Some modifications were made, and suggestions were also accepted from members of the Philadelphia Foundrymen's Association Committee. A report was then brought in, which was sent out for criticism. Thereafter a certain number of criticisms came in to the committee, and on the strength of those criticisms we have made two or three changes. There are, a few slight changes from the report which was given to your Secretary and printed. (Reads and explains changes from printed report.)

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It was moved and seconded that the report be received and accepted.

PRESIDENT ANTHES: Gentlemen, you have heard the report and the motion.

MR. KEBLER: In this report the method of determining sulphur has been made obligatory. It seems to me that ought not to be done until the matter has been taken up more fully. A great many of the furnaces in the country are selling their iron by volumetric determination, and a great many of the foundries are making their determinations for sulphur in the same way. Now a furnace goes to work and sells iron which according to their analysis runs 0.045 sulphur. That is sent to the customer. If he happens to be a chemist who makes his determinations by the gravimetric method, it may be found to run 0.055 instead of 0.045, and the iron is rejected, although the furnace used the customary method and under that method had found the iron entirely within the specifications. Once before in one of the earlier specifications they tried to make a standard difference between the volumetric and gravimetric methods. I believe that was a difference of 0.01; that is, if the iron runs 0.04 volumetric that it would run 0.05 or under gravimetric. That would be all right; but it seems that the difference is not constant at all. In some irons the gravimetric and volumetric determination may show the same sulphur. If another method is used it may show 0.04 by the voulmetric, and 0.06 by the gravimetric. Another iron may show 0.04 by the volumetric and 0.05 by the gravimetric. It seems to me that before this Association adopts a method as a standard which is not in general use among the furnaces which sell iron, or among those users who buy it, or by the chemists, that this matter ought to be certainly taken up more carefully. As far as I have known no work has been done to show that the iron that showed 0.045 volumetric and gravimetric sulphur was any worse for the foundryman than one which runs 0.045 volumetric and 0.055 gravimetric. In other words, the sulphur is certainly combined and the difference in the two methods depends upon whether that additional 0.01 is combined in such a way that it does not affect the iron. I think additional investigation ought to be taken on that point.

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Another point that I think it would be well to straighten out, is in regard to these different classifications; for instance, you make one classification of 1.75 per cent. silicon, another 2.00 per cent., another 2.25 per cent.; and a variation of 25 points is allowed from each. For instance, say we are selling iron to a man, three different grades of iron, 1.75 per cent., 2.00 per cent., and 2.25 per cent., and we ship him another iron that analyzes 2.00 per cent. Now that comes within the three different classes of these specifications. This may seem as if it was an impossible case, but it is not, because we ran across just that the other day. Say we are selling the man three different kinds of iron, 1.25 to 1.75, 1.75 to 2.25, 2.25 to 2.75; and we are shipping him iron that runs just 2.25 Silicon, the question is, under what classification should he pay? The same would apply to some of the other elements.

Another point is the total Carbon which you specify. That would be a very nice thing for us to know; but so far as I know none of the furnaces are analyzing Total Carbon. They may analyze once a day or once a week; but it is not general at all. Some of our customers specify Total Carbon. A furnace that was square in the matter and did not analyze carbon and did not intend to, would say, "Of course our iron is all right, let it go along." But nobody would know what the carbon was. So foundries that have adopted a carbon specification have begun to cut it out.

It seems to me that until this is gone into further it would be just as well not to put it in, even though this is not obligatory.

MR. FIELD: This is a question that has been gone over very carefully by the committee in considering the material that has been submitted to it. Taking it up in order, the question of Sulphur analysis reminds me of the illustration of a party going to one store and buying sugar with scales used that were a half pound short, while in another store full weight is given. You would soon be buying your sugar of the fellow whose scales weighed a pound and not of the fellow that sold by short weights. That is just what you would do with the sulphur proposition, if

you go by the evolution method. They do not appreciate in Ohio and Western Pennsylvania the disadvantage that there is in certain iron in Eastern Pennsylvania by this evolution method. There is one iron that will only evolve fifteen per cent. of its sulphur by any known method. There is a great deal of copper in such iron. All a man has to do if you put in the evolution method for sulphur is to get some iron from the Cornwall district which runs high in copper, and put it into his products, and pretty soon he is selling you on a .06 and .05 basis.

We have taken care of this by simply stating that the gravimetric method shall be used for sulphur analysis unless otherwise specified in the contract. If the foundryman is asleep enough to allow the furnaceman to say that this shall be by the evolution method, that is all well and good.

If a furnaceman is selling me Valley iron, and I know it evolves 100 per cent. of its sulphur, I am perfectly willing to take it; but if I am buying iron in Eastern Pennsylvania iron that I know only evolves .15 per cent. of its sulphur, I am not going to take that on the evolution method. I would make him specify a minus quantity in order to get it up to it.

I have been through this gravimetric method enough to know. It is no hardship, not in the slightest, I do not care who says it is. We have had furnaces show an increase by adopting it. It simply means that every individual iron evolves a definite proportion of its sulphur. If I am using a certain product that carries a certain amount of titanium, or a certain amount of copper, and evolves only a small amount of sulphur, that furnace today is not entitled to sell except on gravimetric analysis. It is not fair that a furnace that has copper iron should add only .01 to their iron when another furnace that evolves all the sulphur should add .01 to its product when it is not right to do so. We have put in here "unless otherwise specified in the contract." That is the history of the sulphur question.

As to the matter of Total Carbon, and referring to the minimum figures quoted in the Report, certain foundries are specify-

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ing minimum Total Carbon, in order to have the metal uniform; and it is only fair that they should. The furnaceman says, "If you will only be reasonable in your specifications," but there are foundrymen who want to know who "Mr. Silicon" is, that want such and such a per cent. of Silicon when certain furnaces cannot make it. Hence the furnaces say, "Get something that we will all know about, so we can put our furnace on a fixed and firm basis for selling pig iron. Therefore, we have put in a reasonable minimum but do not force any one to accept it. If you do use this each furnace will be on the same basis, and the foundryman will know what he gets. It simply specifies that if you do specify Total Carbon, that you agree to use these specifications. I think that answers the only criticism on that score.

The objections and criticisms have all been gone over. I have a letter from a gentleman who took up this matter very completely, and his letter was put into the hands of the Committee. It takes up everything very completely, with the exception of one point to which Mr. Kebler has referred; that was also taken into consideration when this report was finally adopted. I am going to read the end of this letter, because it expresses more clearly than anything else the desires and wants of the furnace people. He says: "In order that the new plans should be a success they should be thoroughly discussed at Cincinnati, and unanimously adopted. What would you think of the idea of having the convention discuss the most of them, and then refer them back to the Committee, at the same time appointing a committee of three pig iron producers to co-operate with your Committee. When finally agreed to this should be sent to the different producers of pig iron for their acceptance; this could be sent to the foundrymen who are willing to buy and the furnacemen who are willing to sell by these specifications. In that way they would be put in effect."

Of course it would be an ideal condition if you could get all objections smoothed out. This report has already been before the Eastern Pig Iron Association. I made an endeavor to get it to some of the Western people. It has been sent to them all individually, and a couple of them have been kind enough to write

criticisms. So far as possible these criticisms have been taken into account and the report is as liberal as we could seem to get it and take care of both ends of it. I will assure you that if anything the report favors the furnaces right straight through. I am frank to say that the furnaceman is the one that has heretofore been getting the raw end of the specifications; because if a furnaceman does not come right up to the mark the foundryman could say, "I have him now; the freight is so and so, and he cannot put it anywhere else if I refuse to take it"; but if he signs a contract as we now have the specifications then he either accepts or rejects the iron at the exact value that is put in when he signs the contract.

MR. STODDARD: I have a few words to say in regard to this very important subject. Take the iron specifications, I am inclined to agree with the first speaker in regard to the determination of sulphur. I do not believe that it is well for you to sepcify that the sulphur must be determined by the gravimetric method unless it has been specified in the contract. As Mr. Field and any one else who is in touch with the chemical work in this country so well knows, the great majority of the sulphur determinations are being made to-day by the evolution methods. While it is true that in some iron we do not catch all the sulphur, it would work a great hardship on the furnaces and on the laboratories—possibly not on the laboratories in the foundries where they have their own chemists who know what the variations are between the two methods—but on the commercial laboratories it would work a great hardship.

It is customary in commercial laboratories to use the evolution method on a large majority of their work where they are doing a large amount of work for foundries; and it is sufficiently accurate for all purposes. I do not believe in a large majority of the foundries it is necessary to split the difference of five thousandths in percentage of sulphur. If you are watching a variation of five hundredths of a per cent. on any material, of course, it makes a difference. I think it is a question of so great importance that it should be given further consideration.

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There is a point which possibly Mr. Field has not investigated; possibly he has; but there is nothing said about it in these specifications; that is, instead of making sulphur determinations by this gravimetric method in all these irons of which you have no knowledge, if you heat the iron for fifteen minutes and then determine the sulphur, you will find you are getting as high sulphur as by the gravimetric method. Most chemists will agree that there are very few determinations which are so unsatisfactory as gravimetric sulphur determinations. That is due to the process of the method; it takes a great deal of care; it takes a great deal of time; and if it is necessary for the ordinary commercial laboratory to make gravimetric determinations on all the work they turn out, it would have to double the force in order to get the work out. I do not believe it is advisable for us to adopt at this time any specifications specifying the method that shall be adopted for these determinations.

DR. MOLDENKE: Are we supposed to follow the customs of the country? Or are we supposed to lead? I do not think we should let other people show us the way, but we should lead. That question of sulphur determination was discussed at three meetings. This was the result obtained in order to help everybody. Really if you would see the correspondence which has come to me about these laboratory determinations and how they vary, you would quickly have the gravimetric method only. I get reports from foundrymen about the different laboratories which they would be surprised to see. They would be worried if they saw the reports that have come to my office on the results of the volumetric method; because the consequences were very bad. I am very much against having us take a method which is known to be wrong merely because it is the custom of the country. Let us change the custom of the country; let us get in advance of our business. Let the laboratory charge an extra price for gravimetric determinations, and you will find that the foundrymen will follow this price all right, do not worry about that.

MR. STODDARD: It may be possible that results have gone out from the Detroit Testing Laboratory which have shown lower sulphur than actually existed in the iron because of this

discrepancy between the two methods; but granting that to be true, I still maintain that my position is right. It is easy enough for the Doctor, who does not depend upon an income from a laboratory to say charge them this extra money; but I know the American and Canadian foundrymen and know it is pretty hard to get them to meet even the low charges. The foundry requires so many determinations in order to keep in touch with its product that they cannot afford to pay for gravimetric sulphur determinations. We would not succeed in getting a contract a month where we would get one a week, if we charged for gravimetric determinations. The foundrymen will not pay it. I think it is absurd to include anything in there which we who have been up against that for many years know it is not practical at this time.

DR. MOLDENKE: When you get down to it you will find that the foundrymen will ask you for the gravimetric only in cases of dispute. Really, this is a meeting of foundrymen trying to improve their industry. I do not know that they will care whether the commercial laboratories are affected by this, or whether the furnaces are affected by it, they are going to look for their own benefit to make this question of sulphur safer as regards their work. We ought to look at it from a very broad standpoint, not from a narrow one.

MR. STODDARD: There is not one chemist in a hundred that can take gravimetric sulphur determinations unless he has had some experience with it for a considerable time.

DR. MOLDENKE: Let him get the experience then.

A MEMBER: I agree with Mr. Field that we want to know what we are getting, and that we are getting all the sulphur in the iron we buy. We want to fix it in such a way that any dispute will be settled correctly, and as this is only possible by the gravimetric method, so let that govern.

MAJOR SPEAR: For a number of years we have been as an isolated body trying to advance the interests of the foundrymen. We have been progressing. We have made at this meet-

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ing a great deal of progress. We are looking for knowledge. I as a foundryman know little about chemistry; but I believe that this report should be adopted; and I would say in reply to the last speaker that if furnacemen and commercial laboratories cannot do it, let us educate them to do it.

(Cries of 'Question! Question!" and applause.)

A MEMBER: In one of the former specifications they said that when sulphur was in dispute it would be settled gravimetrically. The absurdity of that is seen when the furnace sells iron by volumetric determination and when it is brought into question they settle it gravimetrically. That shows the absurdity on the fa e of it.

MR. FIELD: A furnace does not sell iron on volumetric sulphur. A furnace that is making as they do their regular profit on pig iron year in and year out ought to be able to have a gravimetric analysis taken once a week. Every furnace evolves a definite percentage. Now let them add that on the volumetric. The funny part of the thing has been that the people who are doing all the talking and kicking have been the ones who are not affected. Those fellows in New England that have been working right straight along with this evolution method have been keeping right quiet and saying nothing about it and reaping all the benefit of it. I have got six letters in my drawer from people who are kicking, who say there is not five one-thousandths difference between the gravimetric and the evolution methods; yet they are afraid to send out one sample a month to a capable laboratory. If a chemist cannot do gravimetric sulphur analysis he is no chemist at all. I think the foundry wants what is right.

I do not care to talk all the morning arguing on this thing for fear I might say things that would probably hurt somebody's feelings. The thing has been gone over thoroughly. The Committee was a representative one as far as the other two members were concerned When I got on it I insisted on having a repreentative man from New England, and one from Philadelphia; hey have taken it up. The American Society of Testing

Materials has taken it up. The thing has been hashed out for a year. If you have not sent in any criticisms then it is your own fault. The Committee have taken into consideration every possible criticism that has been put up to them. If you are ever going to get a report it would not do any good to refer it back again, you would only get the same thing. If you do not adopt the gravimetric method now you will adopt it ten years from now, and you will just have wasted that much time. (Cries of "Question! Question!")

MR. STODDARD: I cannot agree with Mr. Field's remarks at all that we will adopt it next year or ten years from now. At the present time the gravimetric method is considered the standard. I do know that by samples you can get the sulphur all out gravimetric where you cannot get it all out by the evolution method. Now in the interest of the foundry, not in the interest of the commercial laboratory where I make my living—but arguing for the foundry, as Dr. Moldenke says, every chemist in the country is educating the foundry in no small way in doing its work. I believe that the matter should be left open. —I think the suggestion that a committee from the furnacemen should be appointed to act with this Committee is an excellent one. I move as an amendment to the original motion that the matter be held for further consideration, I do not wish to have this committee consist of Eastern furnacemen only, I think the Western and Northern furnaces ought to be considered in this matter. We ought to have on that committee a man from the North and from the South and from one of the Eastern furnaces, if you please. I move that this matter be held under consideration, and that this additional number of three be added to the committee; that it be given further consideration.

PRESIDENT ANTHES: There is a motion before the house.

MR. KEBLER: This is an amendment to the original motion.

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MR. FIELD: I will not accept the amendment, because you cannot get a representative pig iron man from the Valley. You may get some individual man, but the Valley furnaces will not admit that they are an Association, they will not act as an Association. They may act as individuals but as individuals only their opinion would not carry the same weight. They have told me hundreds of times to go ahead and adopt something, if it is reasonable they will accept it. This temporizing over a thing to protect a few laboratories has been a pretty sore point in some people's minds for quite a considerable time. I am not going to take up time in saying what I think about certain make-shift methods which do not deserve protection. It is all right to discuss annealing samples with chemists, I know we can anneal and drive off the sulphur as well as you can increase it if you anneal it for half an hour. There are a hundred things about the method that make it impossible. No furnace wants to anneal its samples. They claim they have not the time to anneal. It is up to the furnace to keep on using the evolution method and add the difference in reporting. If they are going to charge more for this let them charge it. Therefore I refuse to accept the amendment.

PRESIDENT ANTHES: I believe we will have to vote upon that amendment first.

The motion to amend was now seconded.

The question was taken on the amendment, and the same was lost by a large majority rising vote, only three voting to adopt the amendment. The question being taken on the original motion to adopt the report of the Committee, the same was carried by a rising and majority vote.

PRESIDENT ANTHES: I declare the motion carried, and the Report adopted.

STANDARD SPECIFICATIONS FOR FOUNDRY PIG IRON.

It is recommended that Foundry Pig Iron be bought by analysis, and that when so bought these Standard Specifications be used.

Percentages and Variations.

In order that there may be uniformity in quotations, the following percentages and variations shall be used. (These specifications do not advise that all five elements be specified in all contracts for pig iron, but do recommend that when these elements are specified that the following percentages be used.)

SILICON. (0.25 allowed either way)			SULPHUR. (maximum)			TOTAL CARBON. (minimum)		
1.00	(La)	Code.	0.04	(Sa)	Code.	3.00	(Ca)	Code.
1.50	(Le)		0.05	(Se)		3.20	(Ce)	
2.00	(Li)		0.06	(Si)		3.40	(Ci)	
2.50	(Lo)		0.07	(So)		3.60	(Co)	
3.00	(Lu)		0.08	(Su)		3.80	(Cu)	
			0.09	(Sy)				
			0.10	(Sh)				

MANGANESE. (0.20 either way)			PHOSPHORUS. (0.150 either way)		
0.20	(Ma)	Code.	0.20	(Pa)	Code.
0.40	(Me)		0.40	(Pe)	
0.60	(Mi)		0.60	(Pi)	
0.80	(Mo)		0.80	(Po)	
1.00	(Mu)		1.00	(Pu)	
1.25	(My)		1.25	(Py)	
1.50	(Mh)		1.50	(Ph)	

Percentages of any element specified one half way between the above shall be designated by addition of letter "X" to next lower symbol.

In case of Phosphorus and Manganese, the percentages may be used as maximum or minimum figures, but unless so specified they will be considered to include the variation above given.

Sampling and Analysis.

Each Car Load, or its equivalent, shall be considered as a unit in sampling.

One pig of machine-cast, or one half pig of sand cast iron shall be taken to every four tons in the car, and shall be so chosen from different parts of the car, as to represent as nearly as possible the average quality of the iron.

An equal weight of the drillings from each pig shall be thoroughly mixed to make up the sample for analysis.

In case of dispute, the sample and analysis shall be made by an independent chemist, mutually agreed upon, if practicable at the time the contract is made.

It is recommended that the standard methods of the American Foundrymen's Association be used for analysis. Gravimetric methods shall be used for Sulphur analysis, unless otherwise specified in the contract.

The cost of the resampling and reanalysis shall be borne by the party in error.

Base or Quoting Price.

The accompanying table may be filled out, and may become a part of the contract:— "B" or Base, represents the price agreed upon for a pig iron running 2.00 in Silicon (with allowed variation 0.25 either way), and under 0.05 Sulphur. "C" is a constant differential to be determined upon at the time the contract is made.

SILICON percentages allow 0.25 variation either way. SULPHUR percentages are Maximum.

SILICON.

	3.25	3.00	2.75	2.50	2.25	2.00	1.75	1.50	1.25	1.00
Sulphur —.04	B–|–6C	B–|–5C	B–|–4C	B–|–3C	B–|–2C	B–|– C	B	B— C	B—2C	B—3C
Sulphur —.05	B–|–5C	B–|–4C	B–|–3C	B–|–2C	B–|– C	Base	B— C	B—2C	B—3C	B—4C
Sulphur —.06	B–|–4C	B–|–3C	B–|–2C	B–|– C	B	B— C	B—2C	B—3C	B—4C	B—5C
Sulphur —.07	B–|–3C	B–|–2C	B–|– C	B	B— C	B—2C	B—3C	B—4C	B—5C	B—6C
Sulphur —.08	B–|–2C	B–|– C	B	B— C	B—2C	B—3C	B—4C	B—5C	B—6C	B—7C
Sulphur —.09	B–|– C	B	B— C	B—2C	B—3C	B—4C	B—5C	B—6C	B—7C	B—8C
Sulphur —.10	B	B— C	B—2C	B—3C	B—4C	B—5C	B—6C	B—7C	B—8C	B—9C

(This table is for settling any differences which may arise in filling a contract, as explained under Penalties and Allowances, and may be used to regulate the price of a grade of pig iron which the purchaser desires, and the seller agrees to substitute for the one originally specified.)

Penalties.

In case the iron, when delivered, does not conform to the specifications, the buyer shall have the option of either refusing the iron, or accepting it on the basis shown in the as table, which must be filled out at the time the contract is made.

Allowances.

In case the furnace cannot for any good reason deliver the iron as specified at the time of delivery is due, the purchaser may at his option accept any other analysis which the furnace can deliver. The price to be determined upon by the Base Table herewith, which must be filled in at the time the contract is made.

DR. MOLDENKE: We have one more thing left yet, and that is the question of the next meeting place. I believe we have a representative from Detroit who wishes to talk to us about that subject matter.

PRESIDENT ANTHES: The question of the next meeting place is before the house; we will call upon Dr. Stephenson, who I believe has an invitation to extend to you.

INVITATION BY DR. F. T. F. STEPHENSON, DETROIT, MICHIGAN.

Mr. President and Members A. F. A.:

It is an old and very trite saying that "God made the country, man made the town." And after man had been making towns for about five thousand years some very wise man estab-

lished a little town in the best country that God ever made. They did not push along the progress of the town, thinking they would wait till all the inventions in town matters were worked out; but about ten or fifteen years ago they finished up the product, and they are just putting the last coat of finish to it up there now.

I am referring to the little city of Detroit from which I have come to issue to this organization an invitation to meet with us next year. We issue the invitation to Detroit not for what we can do for you but for what we feel you can do for us. We have had a great many conventions in Detroit in the last ten or fifteen years. We have justly earned the name of "The Convention City of the World." Having been here at this convention for the last week I feel sure that if I am successful in taking back to Detroit the assurance that this convention will meet there next year that I will take back the best assurancee in the convention way that has ever been taken there.

I have associated with the members of this Convention rather intimately for the past five days, and I can assure you that it has been one of the most pleasureable incidents of a rather varied experience.

The city of Detroit will be greatly honored if you gentlemen will come and meet with us next year. You want more than an invitation, you want an assurance that if you come to our city you will be properly taken care of.

I care not to cast any aspersions upon those cities that have entertained you in the past; but I am very positively sure within my own mind that we will take care of you better than you have ever been taken care of before. The reason I say this is because up in the city of Detroit we have taken care of so many conventions that we do not have to put on our good clothes to do it, nor do we have to make any extraordinary exertions. The matter of holding a convention up in our city is just as easily carried out as is a prayer-meeting in the ordinary village. We just make

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up our minds that we want the convention and then we go ahead and make our preparations and then we issue an invitation.

You, therefore, are interested in knowing what sort of preparation we have made for you. The matter was presented to some of us about three months ago; we went ahead first and found out what would be expected of us as hosts. Mr. Lane very kindly came up to the city and spent an evening with some of us, and told us what had been done in the past; we discovered, for instance, that it was considered a very nice thing to properly entertain you. We realized that to "properly entertain" takes money; and we therefore put aside our personal business for three or four afternoons—four to be exact—and when we got through and came to our recapitulation we found we had four thousand dollars in actual real money, in this sense, promissory notes that are payable upon our return to the city of Detroit with the statement that you gentlemen have accepted our invitation.

Since I came down we have had two hundred dollars more given; and we can get four thousand more if we want it. Therefore we assure you that we can take care of you in this way. We think that our experience is sufficient, and our reputation is good enough that you will make no mistake whatever.

We realize that the matter is entirely in the hands of you gentlemen. There are other cities that perhaps will present their invitations in a few moments here; but I do not think it is necessary to waste further time on them. You have a crowded program, and I would suggest that after this invitation the nominations be closed and that the matter be settled so that you may proceed with the more important business matters which await your attention. We have a good town. We have the best town in the country for holding conventions. We are not amateurs at the business. We know how to do it.

In behalf of my city I issue to you a most cordial invitation to meet with us in 1910. On the table behind me rest letters from the Governor of our great State inviting you to come, from

the President of our Board of Commerce, from the Mayor of our city, and from the Secretary of our Foundrymen's Association and from the Secretary of our Convention Bureau. We have gone through all the formalities; and if you care to hear them read we will have them read to you. If you will take my word for it—and I will say this, that I have never been caught in a lie in my life (Laughter)—we invite you to meet with us.

In regard to the time, it has been suggested by one of the most prominent members of your organization, and it seems to me a very good suggestion, that the convention be held the first week in June, Decoration Day, May 30th being a holiday, and your members can very easily leave on Sunday and come up and open the convention on Monday, and they can get away two days by only leaving their plants for one day by having the convention at that time. Every effort will be made to hold the convention at that time.

This has been, I understand, a banner year for the organization. As you know, I butted in and took it upon myself to take care of the registration down-stairs. I handled the registration in order to get next to those registering. I do not know anything about the past, but I know this, that the registration had run up to about 1,800 last night, all being men identified with the iron and brass industry. When a man came and wanted a badge I found out upon questioning him if he was in the iron or brass business, and if he was I presented him with a badge; if he was not, no matter if we gave him a badge we did not register him; therefore the list is an accurate list of the men identified with the iron and brass business, with the exception of perhaps 100 ladies, who added, of course, to the pleasure of the gathering.

I once more invite you to Detroit, and move that the nominations be closed.

MR. BEST: I beg to second the motion that nominations be closed and that Detroit be selected.

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MR. FIELD: I think that is not exactly constitutional. If you will allow me, I will change the motion so that it will be in conformity with our constitution and by-laws. I will move that the next annual convention we recommend to our Executive Committee be held at Detroit, Michigan, in 1910.

Amendment accepted, and the motion to recommend to the Executive Board the adoption of Detroit, Michigan, as the 1910 convention city was now put and carried, with applause.

DR. STEPHENSON: In behalf of Detroit, gentlemen, I thank you. (Applause.)

PRESIDENT ANTHES: I understand that Major Spear has something to say; let us hear from him.

MAJOR SPEAR: I am a younger member of a Committee which has been appointed by the Pittsburg Foundrymen's Association to extend to you an invitation to meet at Pittsburg in 1911. I suppose you are quite familiar with the gold and black colors of Pittsburg. It seems we have lost them. I do not know where or how we lost them.

PRESIDENT ANTHES: They were lost last night somewhere!

MAJOR SPEAR: Are you personal? One of the oldest, one of the original members, I believe they call him the "Father of the American Foundrymen's Association" is here with us. He is a Pittsburger. He can talk a great deal better than I can. The gentleman from Detroit got in ahead of me and said everything that was possible for Detroit—and left me nothing! It reminds me of the case of two negroes who were selling hot popcorn. I have told this story several times to my personal friends, but it seems to be very apropos here. One night as I was going up Broadway I came across these darkies, each with his caldron of hot water and hot corn. The first was a progressive sort of a

nigger, while the other fellow was not so much so. The progressive fellow was hollering, "Hot Corn! Hot Corn!" The other nigger was hollering "Heah too! Heah too!" That covers the situation here. The other gentleman has said everything that I can say.

I have the pleasure of presenting letters from our Board of Trade, our Chamber of Commerce, and the Mayor of our city. I do not know as I can say anything in favor of Pittsburg. We have got a reputation which is an enviable one from certain points. (A Voice: "We had better come and see what it is!") I think we will treat you right. If you are millionaires by the time you leave our hands we will try and make you believe that you are multimillionaires! (Applause.)

DR. MOLDENKE: I believe that Pittsburg is in absolute and definite line for 1911. We had invitations last year—they have not come again this year, but undoubtedly will—from Milwaukee for 1912. It seems they want us; and for 1913 we have an invitation from Niagara Falls; so you see we are blessed with invitations! This time Cincinnati, next year Detroit, then Pittsburg, then Milwaukee; if you have any other places to present let them consult me. We will put them geographically in line and I think we can be provided for to 1920.

MR. SEAMAN, Pittsburg: I do not agree to that, I do not think dead men can vote for anything that is to take place after they are gone!

A MEMBER: I have had considerable association with the members from Milwaukee here lately and they have previously expressed themselves as desiring the convention there. I will guarantee you that when you go there you will have a reception equal to anything you ever met with. I am satisfied from the enthusiasm of the foundry interests in Milwaukee that you will be handled accordingly. (Applause.)

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PRESIDENT ANTHES: It is really gratifying to the members of the American Foundrymen's Association to find how anxious the people are to have us. I remember a few years ago when we had to look around very keenly to get anybody to tolerate us. Now everybody wants to be honored four or five years in advance. I think it is very flattering that our people across the line seem to be endeavoring to get as near that line as they can, and so they have fought to go to Detroit next year. Of course Detroit is practically a Canadian city. I can assure you that Detroit knows pretty well how to take care of a convention. I do not think that Dr. Stephenson has exaggerated at all when he described Detroit as the greatest convention city in the world, although of course Toronto claims preeminence.

DR. STEPHENSON, Detroit: I think your remarks should be further explained. I will grant you that Detroit has a great many Canadian citizens. It is an exceedingly dangerous thing to throw a brick there if you do not want to hit a Canadian; but the explanation is that no man can stand it to live in Canada if he has the price to get out; that is why they come to Detroit!

PRESIDENT ANTHES: The emigration from the United States into Canada last year was 46,000; from Canada into the United States, 223.

DR. STEPHENSON, Detroit: For a good many years the people of the United States have been sending to China and into Central Africa and to all the ill-begotten portions of the world missionaries. There has been a great growth of home missions during the last year; and we sent a great many missionaries to Canada! (Laughter.)

MR. BEST, Montreal: I am a Canadian, and I feel proud of my country. I think I can honestly state that it is the grandest and most glorious country that the sun shines on today. I will state further that the Americans appreciate the

glories of Canada and they love to visit us, and do so frequently; and when they do we try to make them comfortable. I will admit that there are a great many missionaries that come over into Canada, and they find the place so homelike and so comfortable, so genial, that they never like to go back home again, but they send for their friends to come over as fast as they possibly can. They are coming over in herds. (Laughter.)

PRESIDENT ANTHES: I will have to reply to Doctor Stephenson that we do not send around missionaries to ill-begotten countries, we invite only your best citizens. I confess I am proud of the citizens of the United States that have settled in Canada for the last five or ten years. The intercourse between the two countries has now gotten upon a high plane. There is the best feeling between Canada and the United States; we are all Americans. Of course the Americans of the United States have been accustomed to thinking of the American people as mainly South of the great boundary line; but we are all Americans, we are all living for the same purpose and with the same aims.

I think America—Canada and the United States—are standing pretty high in the world to-day as an example of educational and moral progress. I think we can all say that Canada and the United States intend to walk hand in hand along commercial, moral and educational lines for a great many years to come. I think it is very, very pleasant that we can come from the cities of both countries and exchange courtesies that we do between one another; and we always part with good feeling; glad to meet, sorry to part, and happy to meet again! (Applause.)

DR. MOLDENKE: I think the business is about complete. Unless some one has something else to bring before us a motion to adjourn I suppose will be in order.

MR. H. M. LANE: I move we now adjourn *sine die*.

Carried, and adjourned accordingly.

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NEW YORK.

American Foundrymen's Association

A WOOD MILLING MACHINE

By A. N. Spencer, Vice President The Oliver Machinery Co., Grand Rapids, Mich.

It is not my intention to treat the entire subject as put down for me on the program, that is, Pattern Shop Equipments, as this was handled in a very masterly way at the Cleveland convention three years ago. Since that time, however, there has been introduced a machine the possibilities of which are almost limitless.

This is known as the Wadkin mechanical woodworker, made in Leicester, England. This machine resembles more nearly the

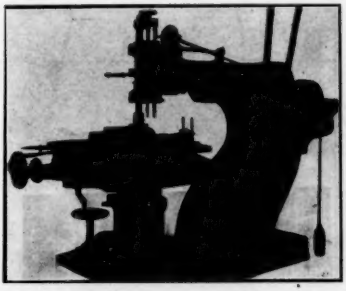

Fig. 1. Fly Cutter Set for Curved Work

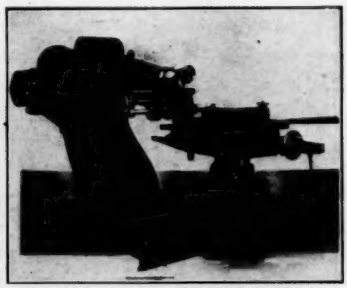

Fig. 2. Machine Set for Core-box Work

universal milling machine found in the tool rooms of high grade machine shops than it does any of the machines formerly used in the pattern shops. All of the uses to which it has been put are not known, as someone is constantly developing new fields for its application. Its universal range renders it particularly desirable in the ever varying intricacies of pattern work. A number of these machines are now in use in different parts of the United States, and in all cases are giving results far in excess of those expected when they were first installed.

The machine which has been in use the longest is located at the plant of the Nordberg Engineering Co., Milwaukee, Wis., and a number of the illustrations shown were taken from work being done upon this machine or of fixtures in connection with it. A machine of this kind is particularly useful in a jobbing pattern shop or in any pattern shop where fairly large and intricate patterns are required. It is also useful for turning out "hurry up"

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or temporary patterns for one casting jobs. In Fig. 1 the machine is shown making a small pipe bend pattern. As ordinarily constructed a pattern of this kind would be made up of several parts turned in the lathe and then united. With the Wadkin machine it is possible to do all the work, including both the straight and curved portions, at one operation. The cutter shown in this illustration can be used either on the inside or outside of the curves, providing the smallest radius on the inside of the curve is not less than one-half of the bottom width of the cutter.

By substituting a different form of cutter the core box for the same piece may be made with great accuracy. The machine is graduated in all directions so that core boxes and patterns can be worked out to fit one another without having to make the large number of measurements usually required in doing such duplicate work.

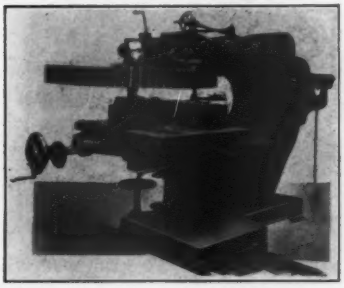

Fig. 3. Cutting a Large Gear

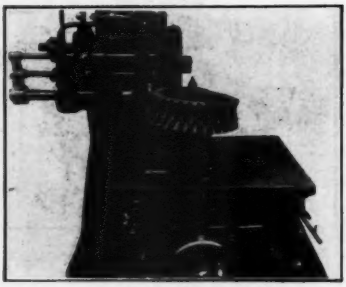

Fig. 5. Cutting a Worm Wheel

In Fig. 2 the machine is shown with the head turned into a horizontal position and equipped with a bar for boring out long core boxes. Core boxes of this type may be made with a fly cutter like that shown in this illustration or may be made with a special curved cutter used near the head, as in the position shown in Fig. 1.

The machine is really composed of two parts, the universal head, which is capable of adjustment in all directions, and the universal table, which is also capable of adjustment in all directions. The table has straight feeds at right angles to each other, can be raised or lowered, or the top of the table can be rotated, thus making it possible to feed the work past the cutter in any desired direction. The machine shown in Fig. 1 is the belted type, while that shown in Fig. 2 is electrically driven.

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For gear work this machine has many especial advantages. In the case of large gears they are turned into a horizontal position, as shown in Fig. 3. The teeth are cut by means of a fly cutter, the table being fed up and down in a vertical direction to accomplish this, the cutter operating at the back of the gear. The machine is provided with an ordinary standard indexing head, similar to that placed on the universal milling machine, and in this case the gear is shown mounted on this head. After the teeth have been cut the inside of the rim may be finished and the fillets between the spokes also finished by using suitable cutters

Fig. 4. Cutting a Bevel Gear

Fig. 6. Worm and Worm Wheel Made on Machine

and turning the head into a vertical position so that the spindle may work inside of the rim or between the spokes.

For bevel gears the index head is tilted as shown in Fig. 4. In this case it is necessary to cut through the gear at least twice, there being a different set for each side of the teeth, and as in the case of the universal milling machine, this does not result in a perfect tooth such as would be formed by a gear planing machine working to a templet. It, however, forms the teeth sufficiently accurate for many purposes.

For the cutting of worm gears and worm wheels this machine is especially useful. Fig. 5 shows the machine in the act of cutting a 20-inch worm wheel. It will be noted that the pattern lumber has been mounted in such a way that the stock for the teeth is supported on the bottom. This prevents the cutter from break-

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ing out or splintering the ends of the teeth during the cutting operation. The worm wheel is mounted on the index head as usual and the spindle of the index head thrown over to such an angle as to give proper inclination to the teeth; the cutter used is an ordinary fly cutter filed to the form of the teeth desired. The teeth of this pattern were cut in thirty minutes, including the setting up of the work on the machine.

Another worm gear pattern with its worm is shown in Fig. 6. This pair of patterns was made complete in fifty minutes, the teeth on the gear and thread on the worm being cut by means of fly cutters. The turning operations may also be done

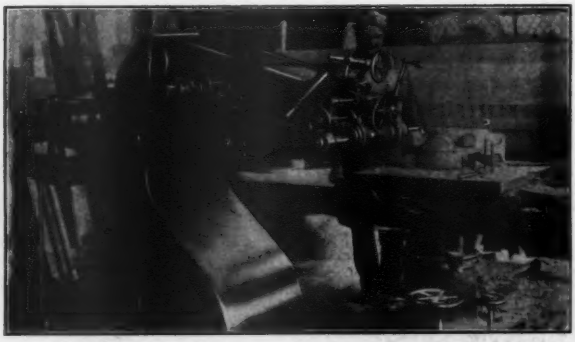

Fig. 7. Cylinder Head Pattern on Machine

on the machine by the use of suitable cutters, the stock being glued up and simply rotated past the rapidly revolving cutter.

In many cases this is much quicker than turning, as the entire job can be finished in one machine at one setting.

There are many intricate patterns, such as cylinder heads, machine frames, and other pieces having bosses and curved surfaces that are very difficult indeed to work out by the ordinary methods, but which may be finished easily on the Wadkin machine. An illustration of work of this type is shown in Fig. 7. In this particular case a small fly cutter is mounted on the spindle in such a way as to work out a pocket or fillet between two of the bosses. By suitably controlling the parts all of the curves about the bosses and fillets between them and other portions of the surface of the pattern may be made upon this machine. In many cases the necessity of laying out the work on the pattern can be

avoided by properly setting the piece on the table and then using the graduations on the table or measuring from the cutter to the work, so as to set the machine in such a way as to cut the desired form. Every job of this kind must be considered by itself; and the solving of these individual problems in the best possible manner is what affects the greatest saving on a machine of this kind.

For ordinary duplicate work it is well known that in the machine-shop the milling machine can be entrusted to cheap help after the cutters have been made and the method of doing the work established. In the tool-room of a machine-shop, however, where the universal milling machine is used for the production

Fig. 8. Radius Fixture for Curved Work

of jigs and fixtures, it is always operated by a high-priced toolmaker. In like manner the returns from the Wadkin machine will depend very largely upon the mental equipment and initiative of the operator.

In many cases it would pay to take a toolmaker or metal patternmaker and let him run the machine. He will soon learn how to handle the woodworking cutters and will make a bigger showing than the woodworker, who is not familiar with the possibilities of machine tools and the methods of using graduated heads, tables, etc. The difference between patternmaking with the Wadkin machine and by hand is exactly the same as the difference between toolmaking by hand methods and toolmaking by highly specialized machinery.

In Fig. 7 there is shown also behind the machine a cylindrical pattern which has bosses and other irregularities on the

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back side so that it could not be turned in the lathe. The cylindrical portion of this was turned out on the Wadkin machine in very short order by simply securing segments which had been sawed to a true circle to the ends of the pattern and allowing these to rotate in suitable bearings or saddles. In this way the work was rotated past the cutter and the circle easily cut.

For handling round work or curved work a great variety of devices have been brought out. In Fig. 8 is shown the jig or radius fixture for curved work. This consists of an extension table which is clamped to the regular table. To this extension table there is attached a vertical spindle A. This spindle is so adjusted that the distance from the center of the spindle to the cutter represents the radius of the work to be turned out, and the work is then mounted on the spindle by means of suitable iron straps or brackets carrying bearings that fit the spindle. Where the work is of considerable width the auxiliary horses shown on each side of the machine are used for supporting the outer portion of the work as it is rotated past the cutter. As the extension table is clamped securely to the regular table of the machine it can be fed in or out, thus increasing or decreasing the distance from the spindle A to the cutter by means of the cross feed attached to the table.

Fig. 9. Special Cutter-head for Large Core-boxes

By running the spindle A to the extreme end of the table shown it is possible to form work 24 feet in diameter. This is used for shaping the inside of the rims of segment patterns for gears, fly-wheels, drums, and other large circular work. It could also be used for much work in connection with large pipe fittings.

In Fig. 2 one method of cutting a core-box was illustrated, and it was stated that another method was to use a different form of cutter when the spindle was in the vertical position, as shown in Fig. 1. Still another method of core-box construction used in connection with fairly large core-boxes is to use the extension

head shown in Fig. 9. The cutters for this head can be adjusted to different radii and by having a number of heads it is possible to cut any desired diameter of core-box. One method of using the head is shown in Fig. 10. In this case the spindle has been thrown slightly away from the horizontal, which would also affect the box somewhat, making it very slightly elliptical, but not enough to make any difference in most cases. Fig. 10 also illustrates an auxiliary table with a slide for long work. The work proper is mounted on the central or sliding portion which runs between the two wooden guides shown. Tables of this kind

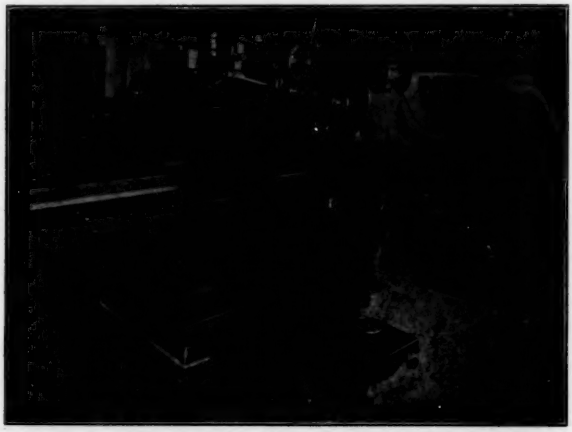

Fig. 10. Large Core-box Cutter and Sliding Table on Machine

have been made capable of taking work 18 or 20 feet long and passing it beneath proper cutters for forming core-boxes or other special work. It will be noted that for supporting the table as it runs beyond the machines, standards equipped with rollers at the top are employed. In the background of this illustration are also seen the two parts of the pattern for a large compressor head. These have been glued up ready for finishing on the Wadkin machine.

In Fig. 11 the machine is shown with the pattern for a 45-inch compressor head on the table of the machine. In Fig. 8 the long radius fixture was shown. In Fig. 11 the table is equipped with a short radius fixture which can be adjusted so as to swing the patterns past the cutter for forming any of the curves in such work as that shown in the illustration. Curves

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on work of this kind rarely require a radius of more than three or four feet. For much of the work on patterns of this kind the head of the machine would be thrown into a vertical position and proper cutters used for working out the different curves or straight portions of the pattern.

Fig. 12 shows one of these machines in the pattern department of the Navy Yard at Portsmouth, N. H. In front of and about this machine are shown a number of patterns and core-boxes which were made upon it. In all cases the time necessary for the construction of these was greatly reduced from that which

Fig. 11. Working on Pattern for a 45-inch Compression Head

would be necessary for the construction of the patterns by hand or by ordinary machine methods, the saving running anywhere from 25 to over 50 per cent.

A machine of this kind will be found useful in the plant not only for the production of patterns but for many special jobs, for instance, in automobile factories, tool-trays for tool-boxes can be routed out upon it; boxes for holding special tools in the tool-room can be quickly formed, and there are also many attachments which make it possible to do special work on the machine.

In Fig. 13 the tenoning attachment is shown. In this case the stock upon which the tenon is to be formed is clamped on the table as shown at the right. The head is first dropped down against the lower stop on the curved arm in front of the head, as shown in the illustration. In this position the revolving cutter

passes under the stock, thus forming one side of the tenon. When this has been accomplished the clamp A is loosened, the arm B is thrown up against the stop C, and the clamp A tightened once more. This brings the cutting head above the work so that as the table is run past the cutter the upper half of the tenon is formed.

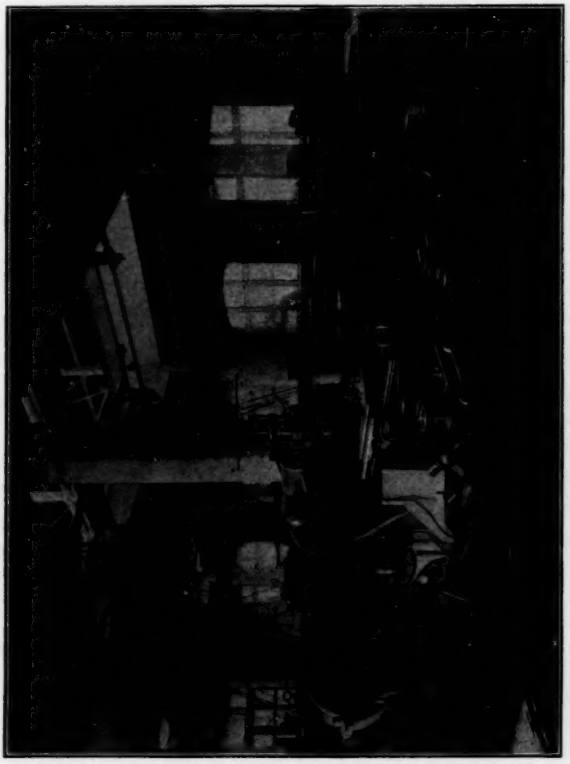

Fig. 12. Woodworker and Patterns Made on It

Similar attachments may be used for the production of large duplicate work.

Some specific savings which have been accomplished may be of interest. In one case the core-boxes having a 40-inch crosshead were cut out by the use of the auxiliary table in 3½ hours, while in the past the work had taken from 15 to 30 hours, depending upon the size of the crosshead. Another case is that of a

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complicated set of core-boxes for some engine work, which were completed in 8 hours upon the machine. The same set made by hand would have taken from 110 to 120 hours, and would not have produced as good a job, as in the case of the work turned out by the Wadkin machine all of the fillets were worked from solid stock while in hand work the fillets would all be put in with

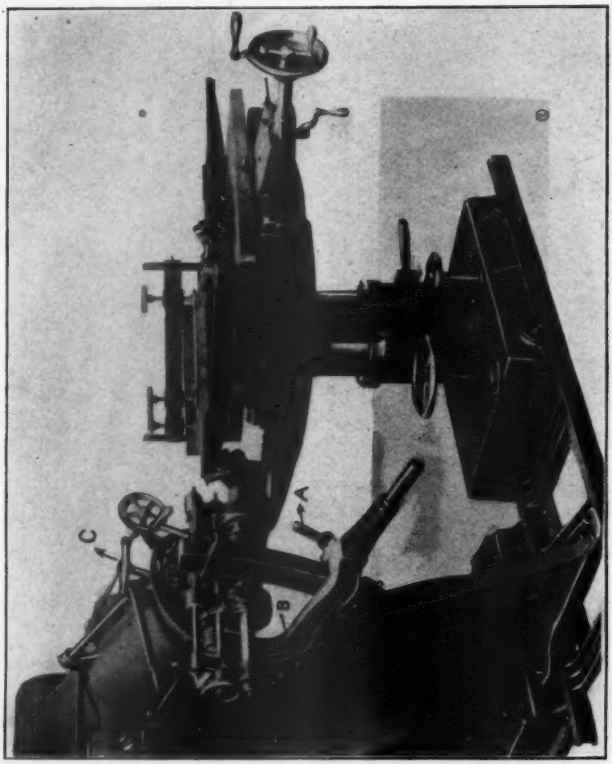

Fig. 13. Special Tenoning Attachment

wax or leather. Another case, that of a pump chamber core-box, was constructed where it required 31 hours to glue up the stock and get it ready for the machine, and 15 hours to finish the core-box on the machine. The old way would have required 200 hours for the job.

The fact has already been mentioned that when using the machine the fillets can be worked from solid stock. In accom-

plishing this in connection with bosses an interesting method is resorted to. With the aid of the machine a place is routed out under the boss to from 3/16 inch to ¼ inch deep. The boss is then turned up with the fillet on it and glued and nailed into the pocket thus formed. This does away with the feather edges on fillets about bosses. This machine makes it possible to construct much stronger joints on many patterns than could otherwise be made, as the parts can be formed quickly and easily on the machine and glued together, after which the pattern is finished in the usual way by mounting upon the regular table of the machine or upon one of the special auxiliary tables and using standard or special cutters.

There is one error which the possessor of a machine of this kind is likely to run into, and that is to charge to the operator of the machine the time only in which the machine is actually working upon the set patterns. The operator must have some time to keep his tools and cutters and other appliances in condition, and some provision must be made for charging this to the various jobs turned out. In ordinary pattern work, however, the patternmaker has to stop to file his saws, sharpen his chisels, and someone has to keep all of the regular woodworking appliances, such as trimmers, saws, surfacers, and so on, in working condition, and the proportion of time necessary for this class of work on the Wadkin machine is no greater than on others. In the hands of a skilled mechanic, however, the Wadkin machine is capable of turning out such a surprising amount of work in a very short time that it makes the time spent in keeping up the equipment appear disproportionately large. This apparent discrepancy in time, however, is due entirely to the unusually rapid work of the machine and the patternmaker who has been accustomed to ordinary methods has to readjust his ideas as to the proportion of time spent in actual patternmaking operations and the time spent in preparing stock, looking after cutters, etc.

With the use of the Wadkin machine it is possible to produce much more accurate castings than can be produced by hand methods, for the pattern and the core-box are both constructed upon the machine and in such a way that all the dimensions can be checked accurately, thus giving exact knowledge as to the metal thickness in different parts. This is of particular value in the case of work made up of curves or combined curves and straight surfaces.

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American Foundrymen's Association.

BOOK NOTICES

Steel for Automobile Construction, and its Microstructure

The Germans have an interesting way of publishing books on special things in special lines, and hence the engineer or scientist instinctively turns to a German list of publications for the latest books on anything he may happen to be looking up.

The Publishing House of M. Krayn, of Berlin, is issuing a series of technical books on automobile construction, among which is the above title. This very substantial book of over 350 pages written by the engineer, Mrs. A. Haenig, of Dessau, Germany, takes up the general information available on the molecular structure, heating and cooling curves of steel, molecular physics, carbon-iron compounds, etc.

The second division of the book is composed of an elaborate discussion of the various classes of steels going into automobile construction. We note all the later and high quality steels extant, which are fully gone into.

Probably the part which will interest the Foundry Laboratory most is the Section of about 100 pages devoted to the microscope in the study of steel and iron. This is practically a book on the subject by itself, and will be found very valuable for those conversant with the German language.

The book sells for 15 Marks unbound in Germany.

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Graphite, a Technical Monograph

This very complete little book, also by Engineer Mrs. A. Haenig, is published by A. Hartleben, of Vienna, in the Chemical-Technical Library No. 323. The book goes into the occurrence and properties of graphite, the methods of mining and dressing up, and use of the material in the arts. The chemical methods of analysis are discussed, and finally its artificial production. To those interested in the subject, this book, written in the German language, is commended. Price unbound in Germany 4 Marks.

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